AN EVALUATION OF CONSTRUCTION CLIENTS' NEEDS AND PREFERENCES

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This work or any part thereof has not previously been presented in any form to the University or to any other body whether for the purposes of assessment, publication or for any other purpose (unless previously indicated). Save for any express acknowledgements, references and/or bibliographies cited in the work, I confirm that the intellectual content of the work is the result of my own efforts and of no other person.

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Abstract

The research investigated factors influencing construction clients' needs with the aim of identifying predictors which could be used for assessing or verifying requirements on future projects. The literature review confirmed that a significant number of clients were not fully satisfied with their project outcomes. It was therefore hypothesised that clients' dissatisfaction could be traced to their needs not being understood and well defined during briefing.

In a structured survey, 593 clients were asked to define and prioritise their project needs; the analysis in this thesis is based on 133 respondents (22%) to this main survey. Clients' transitivity in making preference-choices was first analysed using the psychometric technique of 'paired-comparisons'. 50 clients (41%) were perfectly transitive while the remaining 73 (59%) were intransitive to one degree or the other.

To enhance the subsequent scaling of clients' values and development of hypotheses towards new lines of inquiry, the preferences expressed were used to classify the clients into needs-based homogenous groups using 'cluster analysis'. Four distinct groups of clients were identified, and two of these were chosen for further analysis. The paired-comparisons methodology was again used to measure these clients' values, and, the evaluated desires were statistically contrasted. Although the two groups had similar requirements, their prioritisation of needs differed significantly.

Out of the six factors identified as influencing clients' desires, four were found to predominate in the two groups studied, namely: Social; Personal; Legal; and Project-Induced considerations. Linking clients' needs with these predominant factors will provide an empirical basis for evaluating their requirements during briefing. Project delivery and client satisfaction will be optimised if the impact of these factors on client's needs is identified at project inception.

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List of Abbreviations

BMDP	Medical software for statistics
BS	British Standard
CDM	Construction Design and Management
CIRIA	Construction Industry Research and Information Association
CLUSTAN	A software bearing the name of the Company that produced it
COSHH	Control of substances hazardous to health
CSSC	Centre for strategic studies in construction, University of Reading
DETR	Department of the Environment, Transport and the Regions
DoE	Department of Environment, UK
EDC	Educational District Council
H&S	Health and Safety
LA	Local Authority
MINITAB	A software bearing the name of the Company that produced it
NEDO	National Economic Development Organisation
NFHA	National Federation of Housing Associations
NTSYS	A statistical software for multidimensional scaling and cluster analysis
SAS	Statistical Application Systems
SDS	'Scheme Development Standard' : A performance standard published by the Housing Corporation, London
SEBE	School of Engineering and The Built Environment, University of Wolverhampton
SPSS	Statistical Package for Social Sciences
SQL	Structured Query Language

Definitions

Phrase	Meaning
Bounded rationality	Behaviour that is 'intendedly rational, but only limitedly so'. This comes about due to limited knowledge, foresight, skill and time. It means that no-one knows everything (Pitelis, 1993).
Categorisation	The grouping of objects/people without a quantitative relationship between them (Nunnally, 1978).
Client	An individual or organisation who commissions a building project (Bryant et al., 1969), and, pays for the design and construction of the building (British Property Federation, 1983).
Clients' characteristics	Identity features of a client such as financial status, social status, etc.
Clustering	Grouping of objects, persons, activities, settings, etc. with similar characteristics (Robson, 1993).
Construction Project	"The sum of planned activities, materials or otherwise, of an organisation to convert an idea or a design for engineering or construction work to fulfil human or economic needs within limits of quality, cost and duration" (Santana, 1990).
Corporation	Is interpreted to include large private companies, small firms, academic institutions and governmental agencies (McCuen, 1998).
Decision	A conclusion or judgement (Leigh, 1983)
Decision Making	A rational selection of a course of action from amongst alternatives (Weihrich and Koontz, 1993).
Decision theory	The study of how decisions are or ought to be made (Coombs et al., 1970).

Definitions continued

Desire	Intensity with which a need is liked
Management Information System	A formal system to gather, integrate, compare, analyse and disperse information internal and external to the enterprise in a timely, effective, and efficient manner (Weihrich and Koontz, 1993).
Measurement	The assignment of numbers to objects or individuals as a means of representing their properties (Allen and Yen, 1979).
Motives	Personality factors that influence clients to desire needs the way they do
Multi-stage sampling	Sampling within samples (Mouly, 1978; Weiss, 1995)
Needs	Requirements attached to building products/production
Programming/ programmer	The American name for a briefing / brief developer (Hudson et al., 1991)
Project Inception	Period of initiating a construction project prior to any design work.
Property Developer	One who builds for selling out or leasing (Walker, 1989)
Psychometry	The branch of psychology dealing with measurement (Reber, 1985).
Psychometric Scaling	Measuring the amount of a subjective/mental stimulus

Definitions continued

Purposive Sampling	A procedure in which the researcher uses his or her judgement to select those respondents that best meet the needs of the study (Bailey (1987).
Rationality	An analysis and evaluation of alternatives in terms of the goal(s) sought, needed information, and desire to optimise (Weihrich and Koontz, 1993).
Scale	An organised set of measurements, all of which measure one property or a trait (Allen and Yen, 1979).
System	A set or assemblage of things connected, or interdependent and interacting, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan. For any system, there must be boundaries that separate it from its environment. (Weihrich and Koontz, 1993).
Taxonomy	The theory and practice of classifying objects (Everitt, 1993).
Test	A device for measuring the property or behaviour of an individual (Allen and Yen, 1979).
Trait	Any distinguishable and relatively enduring way in which one individual differs from others (Guildford, 1959).
Type I error	Rejecting the null hypothesis when it is in fact true (Weiss, 1995).
Type II error	Not rejecting the null hypothesis when it is in fact false (Weiss, 1995).
Typical	One of several who are considered to be alike

CHAPTER ONE

INTRODUCTION

CHAPTER ONE : INTRODUCTION

1.1 Background

This research was necessitated by the outcry that clients' needs are seldom achieved in construction projects, (Atkin and Pothecary, 1994; Potter, 1995), with end products often being different from desired and conceived client-goals (Globerson, 1997). Although these referenced sources have indicated some element of client dissatisfaction, other sources (DoE, 1992; Bresnen and Haslam, 1991; Mustapha and Li, 1995; and, Davenport and Smith, 1996) have hinted that the clients they studied were reasonably satisfied with their project outcomes. It would therefore seem that client (dis)satisfaction can be attributed to part and not all of the population of construction clients.

There is no evidence to indicate whether the achievement of needs, where it has been reported, was coincidental or pre-planned. The vast amount of reports on client dissatisfaction seems to suggest that the achievement of clients' needs in construction is probably a chance event. If the achievement of clients' needs has hitherto been a chance event, then, how can it be optimised in the execution of future projects? If however it has not been a chance event; then, how can the under-achievers benchmark their practices from those of the achievers? It was these questions that this research sought to address.

Client satisfaction with project outcomes is dependent on the achievement of needs. It follows then that construction clients would be fully satisfied if their requirements were adequately met. The antonym of satisfaction is frustration (Graham, 1980; Moleski, 1978). It can thus be surmised that, those clients whose needs were not fully achieved are (probably) frustrated with their project outcomes. This supposition can be inferred from some literature reports which have expressed that: the non-achievement of needs has often left clients dissatisfied (Cherns and Bryant, 1984); and, without assurance that the construction industry will do a good job for them in future (NEDO, 1988).

The non-achievement of clients' needs is an issue of high concern to clients (Franks, 1990; Masterman, 1992), especially that construction products are not readily replaceable like some other manufactured commodities, and, the price of remedying faulty products is relatively high. It is also a chronic issue, as it has been reported over a fairly long period of time. References to this effect include Goodacre et al. (1982); Trickey (1982); Walker (1989); Franks (1990); Latham (1994); Building (1995); and, DETR (1999). The query then is why are the needs of some construction clients not fully achieved in their project schemes?

1.2 Why construction clients' needs are not fully achieved

According to Langford et al. (1995), one prime reason for the non-achievement of clients' needs is that constructors often fail to understand what clients really want. Fawcett, (1989) had earlier explained that the needs of clients are defined by project team members who use their own intuition and subjective opinion in the process. Other sources (Carrington, 1979; Andrews, 1983; Ong et al., 1991; Solomon and Evans, 1992; Sung, 1992) have suggested that service providers tend to filter clients' needs with blind-spots through the eyes of professional ideologies.

From findings of a research investigation, Fawcett (1989) demonstrated that, clients and users on one hand, and professionals on the other, varied in their conception of the priorities of construction projects. He also pointed out, that different groups of professionals varied in their perception of the priorities of a particular project. A common explanation that professionals often put forward for their differing opinions is often under the guise of experience.

In property development, products are made for any member of the public to buy at will. This could be likened to the purchase of any other commodity where the buyer does not have a direct involvement in the decisions leading to production. On the other hand, the traditional mode in construction engineering is to produce facilities on demand where each product is specifically made in accordance with the demands of a given client. The essence of a construction project then, is to deliver as precisely as possible, what the client wants (Andrews, 1983). Thus, individual clients' needs should be targeted for achievement in construction schemes. This implies that each client's needs and the values attached to them must be fully understood before successful and satisfactory projects can ensue (Burt, 1978). If for any reason constructors fail to understand what the client wants then they can neither guarantee to offer the right product nor full satisfaction to that client.

There is another dimension pertaining to the improper identification of needs which, is caused by the clients themselves. The first aspect of this dimension is that corporate clients have conflicting objectives (Goodacre et al., 1982). Although corporations have unitary identities, they are composed of several individuals and departments that are complexly interrelated (Green, 1996). The complex nature of corporations is such that decision making responsibilities (concerning their construction projects) may lie with several individuals or departments who may have conflicting goals (O'Reilly, 1987).

The second aspect, which is more serious than the first, is that some clients seldom know what they want (Harlow, 1992; Potter, 1995). This ignorance may, for obvious reasons, be grave on the part of inexperienced clients (Mackenzie, 1979). Those clients who do not specifically know what they want can easily subscribe to any project solution proposed to them by construction professionals. The danger there is that, such clients can later change their minds and then blame professionals for giving them the wrong advise or product.

The foregoing discussions suggest, *inta alia*, that inaccurate assessment contributes towards the non-achievement of clients' needs in project schemes. The reasons why clients' needs are inaccurately assessed could individually, or in combination, deter the optimal achievement of these needs in the course of project delivery. Since clients' requirements remain an important yardstick upon which satisfaction with construction products or projects would be assessed, efforts aimed at defining these requirements more accurately should not be undervalued. Thus, the research focused on how to identify more easily and accurately, what construction clients really want.

1.3 The problem

1.3.1 Approach to the problem

Despite some of its peculiarities construction entails a production process, as in manufacturing, where you feed-in information at the beginning of the process, and, men and machines (resources) translate the information into components which are assembled to give the end product. Given the right resources for any project, the nature of the outcome, either good or bad, rests with the information fed into it. Given the knowledge, skills and experience of construction personnel, it can be argued that the construction market has an ample supply of capable personnel who can deliver diverse kinds of construction schemes. Therefore it was implied, by the researcher that, dissatisfied construction clients are a consequence of inaccurate information concerning their needs being fed into their construction processes.

A project manager or whoever is responsible for bearing the construction project risk(s) owes it a duty to obtain the right information from the client; input it into the production process; and, monitor its correct translation along the production line. From this perspective the research dwelled on the generation of correct information at project inception, with the supposition that it can be transmitted along the production process with minimal distortion.

Although construction projects could stretch over long periods of time, most of the information needed to undertake their production could be generated at the inception phase, as it is the case with a tailor taking measurements for a dress prior to sewing. Thus, project information generated during briefing often concerns all aspects of the intended built facility including the administrative procedures and personnel needed to bring about the end product. In this light this research focused on project inception, especially briefing, and, examined how specific clients' needs could be assessed more accurately.

1.3.2 The problem statement

Against the foregoing perspective, the problem statement is as follows:

> Where do the values of construction clients lie in terms of construction project requirements, and, what does an identification of the major factors underpinning the priorities of the clients reveal for the evaluation of future clients' requirements in the course of construction briefing?

Section 1.2 identified inaccurate assessment as one major source why clients' needs were not fully achieved in some project schemes. The problem then is, while generating information for a construction project, how do you identify what the client wants with greater precision?

Before the requirements of a project can be fully understood, the client (owner) who harbours them must be sure of what they are and be able to express them precisely (Powell, 1991). However, some clients do not often fully perceive their needs (Potter, 1995), and, factors underlying some clients' desires might be beyond their cognitive ability (Hakim, 1987). An empirical study could objectively identify such factors which, could then be used as predictors for identifying (future) clients' needs, especially when the clients involved cannot fully express what they want. These predictors can also be used to verify the needs of clients who seem or claim to know what they want.

The traditional way of ascertaining what clients want is by asking and listening to them where: questionnaires, inquiries, and surveys can be useful channels of communication (Smith, 1994). With human behaviour and needs being diverse (Murray et al., 1993), a rationalised approach might be needed to fully understand the nature of clients' construction needs. Having seen that, clients sometimes cannot decipher or express what they want, alternative means of understanding their requirements may be worthwhile. The empirical search for factors influencing clients' requirements, as sought in this research, provides an avenue for establishing clients' needs and thus construction project objectives.

1.4 Aim and objectives of the research

The research aimed at searching for predictors, which could be used for identifying and/or verifying clients' requirements during briefing. This quest, is supported by a scholar with the following words:

> "without articulating values, the client, programmer, and designer are like sailors on ships without rudders - wandering aimlessly in a sea of goals, objectives, facts, wants, needs, and desires. Perhaps the currents or tides of unspecified values will lead them safely to their destination, perhaps not. A far more certain course can be followed with specified values to focus upon" (Hershberger, 1985; pp.11).

The objectives of the research were to:

1. Study the information supplied by construction clients for reliability, as per making transitive statements in respect of their project values;
2. Analyses clients' preferences for similarity with the view of identifying needs-based homogenous groups which may be (in)finite in number;
3. Evaluate empirically the prioritisation of needs by construction clients, so as to identify critical requirements; and,
4. Evaluate and identify factors underpinning the requirements of construction clients with a view to linking critical clients' needs with major influences.

1.5 Main hypothesis

Following on the foregoing objectives four general hypotheses were defined to give a broad perspective of each subset of the investigation. These general hypotheses are different from statistical null and alternative hypotheses. They provide a framework upon which the analyses are to be approached. They follow-on, and, address the objectives (Leedy, 1993). Thus, since there are four research objectives, there are likewise four main hypotheses, which are:

1. Construction clients are consistent in stating their project preferences;
2. Construction clients' preferences are unique;
3. Construction clients desire their different needs with equal magnitudes; and,

4. No predominant factors influence the project values of construction clients.

1.6 Main assumptions

A research should be based on some assumptions (Leedy, 1993). These assumptions are concepts, which are held constant as their interference can invalidate the investigation or its outcome. The present research was based on two assumptions, namely:

1. Many construction clients shall continue to procure fresh projects instead of buying from the market, thus necessitating the accurate identification of their specific needs by construction professionals prior to production.
2. Clients who provided data in the course of the research have the feel of the subject matter, and, they did respond appropriately to the questions posed to them.

1.7 Usefulness of the study

The investigation has potentials that are beneficial to clients, producers and professional advisers in the establishment of project requirements. These potentials are:

1. It would provide clients with an avenue for discovering their project requirements with greater precision (Palmer, 1981; McLain, 1992);
2. It would enable constructors and client-advisers to evaluate clients' requirements more accurately, which is an area of major concern (Kelly et al., 1992; Beeston 1984);
3. It would enhance the planning and delivery of more accountable projects through the more accurate evaluation of clients' needs (Sung, 1992; Palmer, 1981);
4. The evaluation of clients' needs would also help in the evaluation of design alternatives (Warszawski, 1984), being that clients' requirements underpin design solutions (Moleski, 1978; Goodacre et al., 1982); and,
5. The evaluation of clients' needs in the research would enhance the making of good decisions in construction production, as the needs serve as choice criteria (Sanoff, 1977; Leigh, 1983; McKillip, 1987).

1.8 Delimitation

Time and resource constraints and, an effort to cover a limited scope with more depth warranted a delimitation of the study. The research was in this wise streamlined as follows:

1. The investigation studied opinions from clients who have expressly procured building (but not necessarily civil engineering) projects.
2. Clients' needs as considered in the research were not distinguished between those of the owners in particular and those of the users of the building facilities. It was deemed that owners who were studied would express both sets of needs by considering the end use of the buildings. Notably, more acceptable buildings will be produced by considering the users' needs (Sanoff, 1993). Also, the public and professionals' views must be accommodated in design and project decisions (Hershberger, 1985). However, reasons pertaining to parsimony limited the study to building owners only.
3. There are many types of clients with varying objectives (Walker, 1989), but due to a tight time-frame for conducting the research, the investigation was at some stage limited to two selected needs-based groups of clients.

1.9 Main findings

On the basis of the investigation conducted, the following are listed as the main findings:

1. Without assistance, most construction clients cannot state their needs consistently.
2. The current critical needs of construction clients were observed to be quality, safety, and functionality of building products. Further, while the studied clients rated the project objectives highly they had varying likeness for the means by which their objectives were (to be) achieved.
3. Four needs-based groups of clients were empirically observed in this research. These four groups which consisted of 44, 37,23 and 11 members were named as G1, G2, G3 and G4 respectively. The groups differed in their prioritisation of the eight generic needs upon which they were studied.

4. Some predominant attributes, which do influence the project values of construction clients, were evaluated. Those established in the research were:
    a) Clients' business function(s);
    b) Type of facility to be built;
    c) Type of development (whether new or refurbishment);
    d) Type of customers the clients have to deal with;
    e) Expressed desires/opinions of the client's customers;
    f) Needs of the users of building facilities, other than clients themselves;
    g) Consideration of facility users with special needs;
    h) Planning regulations;
    i) Building regulations;
    j) Advise of in-house professionals; and,
    k) Size of building(s) and/or rooms.

These most influential attributes were observed to pertain mostly to personal; sociological; legal; and, project-related origins. None of the economical and political attributes evaluated were found to have a very high impact on the priorities of the clients.

1.10 Organisation of the thesis

This report is organised in ten chapters. The inter-relationships between these chapters are shown in Figure 1. The present chapter has explained the nature of the investigation. The problem statement and main hypotheses were specified, amongst other issues.

Chapter two is a literature review on clients' needs where the considerations included a definition and compilation of construction clients' needs. Techniques for evaluating these needs are reviewed from a psycho-management perspective, leading to the adoption of paired-comparisons as the tool used in evaluating clients' needs in this research.

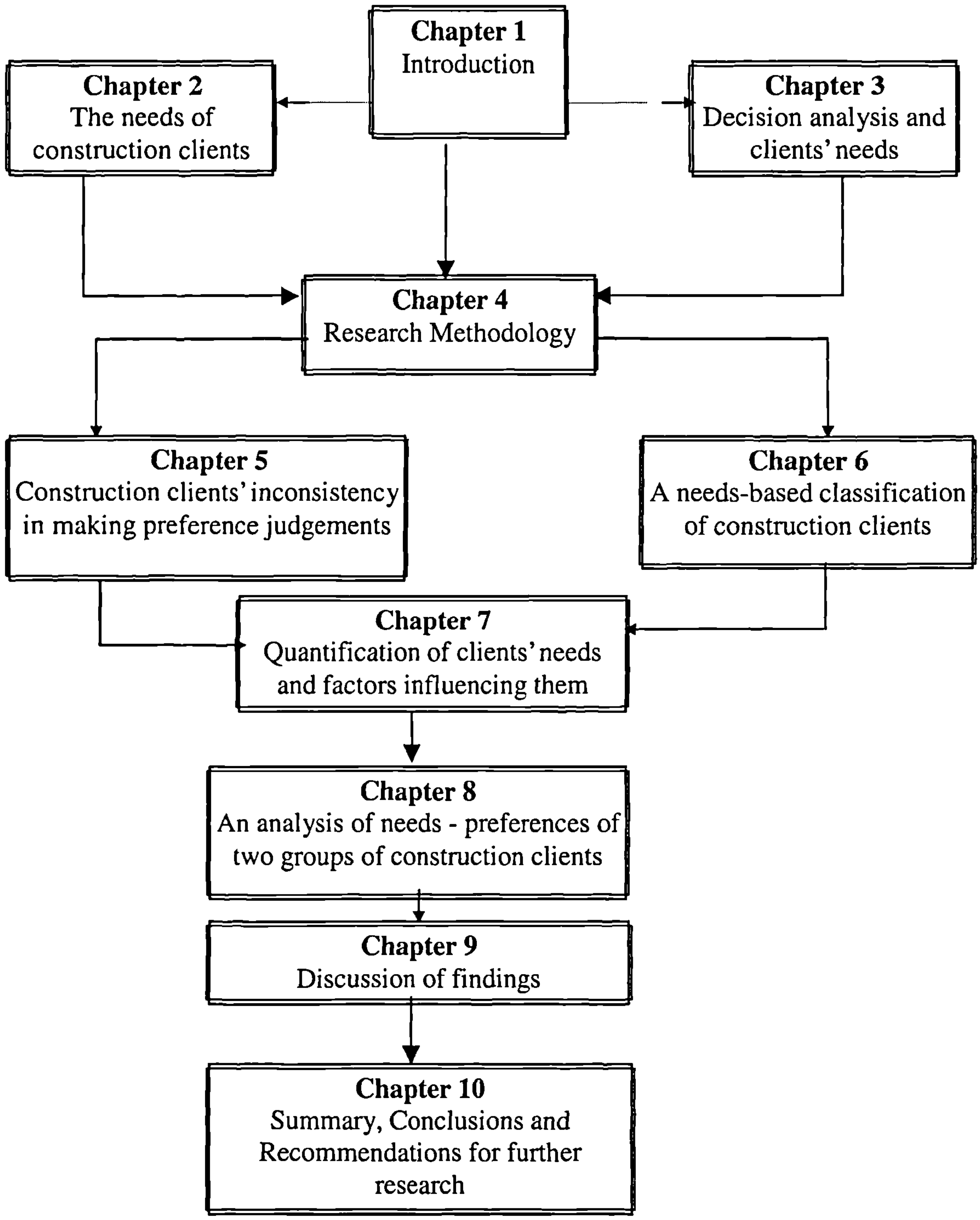


Figure 1 : Inter-relationship between the chapters of this report

Chapter three, titled 'Decision analysis and clients' needs', supplements chapter two. It describes empirical decision analysis to highlight the importance of (construction clients') needs as choice criteria. The techniques proffered for decision analysis are highlighted, showing that different forms by which needs are evaluated to support the different decision analysis techniques.

Chapter four discusses the research methodology where the analytical survey method and, a cross-sectional design were specifically selected for the investigation. The data needed for addressing the general hypothesis, their mode of collection, screening, treatment and analyses are accordingly highlighted in this chapter. The types of sampling employed in soliciting information from construction clients are also described.

In chapter five, data were analysed in respect of the first general hypothesis. The data generated from 123 construction clients were individually analysed for inconsistency of judgement. Using the concept of "analysis of circular triads" (Dunn-Rankin, 1983) the analyses were able to categorise each client as having provided (in)consistent, and thus, (un)reliable information in respect of his/her/their construction project requirements.

Chapter six concerned the empirical classification of construction clients. The research design and the second general hypothesis were such that construction clients had to be stratified into homogenous needs-based sub-groups so that their needs could be evaluated at group levels. The principle of 'cluster analysis' was used in stratifying the sampled clients into homogenous sub-groups. Given its depth, cluster analysis was allocated to a whole chapter where its theory was explained prior to its usage.

Chapter seven dealt with the measurement of data. Having identified the research variables, they had to be measured. The independent variables in this research, i.e. factors influencing clients' needs, were measured by customary descriptive statistics. On the other hand, clients' needs-preferences, the dependent variables, were evaluated by the method of 'paired-comparisons'. Since this method is not popular in construction texts, it was described to provide greater clarity to the report. The evaluations in this chapter enhanced the study of the third and fourth general hypotheses.

Chapter eight covered the remaining analyses, which were done in respect of two groups of clients that were sampled for this purpose. Initially a comparative analysis of the definitions the clients attached to needs was performed. Having measured the values of these clients in chapter seven, chapter eight proceeded to analyse them to reveal the (distinctive) priorities attached to eight generic needs by the selected two groups of clients. The patterns displayed by the desires of the two groups were also studied, after which the differential degrees by which some identified attributes influence(d) the clients' values were compared and contrasted. Predominant attributes, which influenced the clients, were isolated and their origins were traced to factors such as: sociological; legal, etc.

Chapter nine discusses the results in which sundry issues concerning their reliability are deliberated. Chapter ten summarises and concludes the report and makes recommendations for further research.

CHAPTER TWO

THE NEEDS OF CONSTRUCTION CLIENTS

CHAPTER TWO : THE NEEDS OF CONSTRUCTION CLIENTS

2.1 Introduction

Since the research was on construction clients' needs, it was appropriate that needs be defined, to forestall a misunderstanding of the usage of the term. It seems that different meanings are implied in literature when the phrase 'needs' is used. Some of these meanings are explored in this chapter in a bid to clarify the concept with regards to its usage in this research. Sequel to the definition, construction needs were identified and their characteristics examined. The reasons, principles and techniques for evaluating needs are reviewed, and, a methodology for evaluating clients' needs in the investigation is adopted.

2.2 Definition of needs

Kotler (1991) described a need as a felt deprivation pertaining to health and well-being. Reviere et al. (1996) defined it as a gap between real and ideal conditions. The inference is that a need is a deficiency of some sort. However, not all deficiencies can be termed needs as there are qualifications that accompany the definition. According to some sources (Gould and Kolb, 1964; French and Saward, 1975), a need must be desired with regularity so as to be treated as a feature of one's personality. This qualification excludes temporary deprivations. However a chronic deprivation pertaining to any type of building accommodation like offices, residential houses, shops, etc., would be considered as a building need (Cecil, 1993; Turner 1990; Harvey and Ashworth, 1997; Construction Industry Board, 1997).

There is another term, 'wants', which is closely related with needs. Wants have been described as goods and services that satisfy the cravings for mental and physical pleasures (Hanson, 1980; Ruddock, 1992; Gilpin, 1973). While needs connote necessities, wants are qualified by individual preferences. For example, two people might both need housing accommodation. While one of them might want a flat the other might want an elegant detached bungalow.

However, Witkin (1984) explained that when used as a verb, "needs means wants", as in: "he wants food". Along this line, Hillebrandt (1984) inferred that a construction client who has a gap in the use of a building facility would be said to be in need. This gap could pertain to the standard of the facility (e.g. the aesthetics; quality of the finishes; brand of windows; etc.) and is felt by either users or owners of the facility.

On the basis of the foregoing explanations, construction clients' needs could be described as either desires for new facilities or, refurbishment works to upgrade present facilities to a more desirable standard. Incidentally some clients' requirements in construction production, such as: timeliness of completion, safety of construction, price of production, etc. have been referred to, as clients' needs (see, for example: Bennett and Flanagan, 1983; Brown and Scarbrough, 1993; and, Marsh, 1999). The phrase needs thus seems to have a stretched meaning in construction literature with the three phrases: needs, wants and requirements being used interchangeably, with needs being the more popular (Graham, 1980). To maintain a consistency with reference material, 'needs' is used henceforth to refer to clients' requirements concerning their construction projects.

Hillebrandt's (1984) opinion in respect of needs considered clients to consist of both the owners and users of construction facilities. While this may be acceptable, the present research was limited to a study of owners where section 1.6 had explained the reason for such a limitation.

2.3 Identification of clients' construction needs from literature

Being that construction clients' varied needs are not listed in any one documented source an attempt to compile them was made in the course of the research. This was initially done through a literature search where 34 descriptions of needs were identified. These are shown in Table 2.1.

Table 2.1: Compilation of clients' construction needs from literature

Needs	
1	Avoidance of claims (Mackenzie, 1979)
2	Avoidance of disputes (Mackenzie, 1979)
3	Balance between capital and life cycle costs (Potter, 1995; Masterman, 1992)
4	Beautiful exteriors (Franks, 1990)
5	Beautiful finishes and decorations (Franks, 1990)
6	Beautiful interiors (Franks, 1990)
7	Beautiful looking product in general (Potter, 1995; NEDO, 1975; Masterman, 1992)
8	Building to be efficient with intended purpose (Cherns and Bryant, 1984; NEDO, 1975; Masterman 1992)
9	Building to reflect client's activity and image (Bennett and Flanagan, 1983)
10	Clear allocation of responsibilities (Flanagan et al., 1986)
11	Desire of client to be actively involved in project schemes (Hewitt, 1985; Day, 1994; Masterman and Gameson, 1994)
12	Desire of client to be kept informed of project developments (Hewitt, 1985; Day, 1994; Masterman and Gameson, 1994)
13	Durable buildings (Potter, 1995)
14	Early start of physical construction (NEDO, 1988 and CSSC, 1988)
15	Familiarity with contractor (Anonymous)
16	Fast designs and constructions (Flanagan et al., 1986; Bennett and Flanagan, 1983)
17	Firm contract price with minimal variations (NEDO, 1988; Masterman, 1992; CSSC, 1988; Franks, 1990).
18	Flexibility to change designs during construction (Hewitt, 1985; Naoum and Langford, 1987; Franks, 1990)
19	Guarantees on construction and or products (Potter, 1995; Dickinson, 1979)
20	Innovative designs (Incorporating high/latest technologies) (Bennett and Flanagan, 1983; Chartered Institute of Building, 1980; Franks, 1990)
21	Keep existing buildings operational (where necessary) during construction (Bennett and Flanagan, 1983)
22	Lowest price of product (Naoum and Langford, 1987; Masterman and Gameson, 1994)
23	Maximising taxation benefits (Bennett and Flanagan, 1983)
24	Minimal exposure of client to risk (Arditi and Gunaydin, 1997)
25	Minimal interference with the works (Anonymous)
26	Non-confrontational relationship with contractors (NEDO, 1988 and CSSC, 1988)
27	Price of product to meet budget (Flanagan et al., 1986; Cherns and Bryant, 1984)
28	Probity: internal and public accountability (Merna and Smith, 1990)
29	Quality of product to match existing standards (Potter, 1995; Ashworth, 1991)
30	Recognition of risks and uncertainties associated with projects (NEDO, 1988 and CSSC, 1988)
31	Reducing tendering costs by inviting few bidders (Anonymous)
32	Securing timely planning approvals (Mackenzie, 1979)
33	Timely construction (Cherns and Bryant, 1984; Dickinson, 1979)
34	Value for money (Flanagan et al., 1986; NEDO, 1988 and CSSC, 1988)

2.3.1 Collation of clients' needs

Flanagan et al. (1986), Moleski (1978) and Engel et al. (1990) seem to suggest that some of the needs in Table 2.1 can be grouped under broad topical concepts. Consider the aspect of 'project duration' for instance. This was found in the aforementioned descriptions to encompass the features of early start, timely completion, earlier completion, securing timely planning approvals, etc. In view of apparent connections between some of the compiled needs, the thirty four descriptions in Table 2.1 were by reasons of communality and semantics collated into eight groups of generic needs, namely: aesthetics, economy, functionality, quality, safety, commitment (lack of surprises), working relationships and time. This collation, which was done subjectively by the researcher, is shown in Table 2.2.

A collation of needs as in Table 2.2 should not be deemed as exclusive, but serving a purpose (Engel et al., 1990). It is acknowledged that some scholars (like Arditi and Gunaydin, 1997) have viewed all clients' needs as components of quality. However with features such as time and relations in the foregoing compilation, it was impracticable for the present concern to consider all the needs as features of quality. The definitions in Table 2.2 were instead used in the course of the research.

2.4 Categorisation of needs

The numerous needs of mankind are multidimensional in perspective. This feature of needs is attested to in the classifications to which they have been assigned by some scholars. Examples include the classifications proffered by Maslow (1954), Guildford (1959), Engel et al. (1990), etc. Two classifications that bear on the present research are highlighted below.

2.4.1 Essential versus desirable needs

According to O'Reilly (1987) this type of classification would tell you which needs are necessities and which are merely optional. Within the essential category there could be less essentials that are not critical but useful for the comparison of two or more alternatives.

Table 2.2: Grouping of clients' construction needs

NEED	Features
Aesthetics	1) Beautiful looking product 2) Prestigious building
Economy	1) Lowest price 2) Price of the product to meet the budget 3) Reducing tendering costs by inviting few bidders. 4) Balance between capital and life cycle costs 5) Maximising taxation benefits 6) Indication of firm price with minimal variations
Function-ality	1) Building to be efficient with intended purpose 2) Durable building 3) Keep existing buildings operational during construction
Quality	1) Quality of the product to match current standards 2) Innovative design incorporating high/latest technology 3) The building should reflect the client's activities and image 4) Value for money i.e., desired quality at appropriate price
Relations	1) Avoidance of disputes 2) Familiarity with contractor 3) Desire to be actively involved and kept informed about the project throughout its life 4) Non-confrontational relationship with the contractor 5) Internal and Public accountability
Safety	1) Minimal exposure to risk for the client 2) Recognition of risks and uncertainty associated with the project
Commit-ment (i.e. Lack of Surprises)	1) Clear allocation of responsibilities 3) Flexibility to change the design (even) during the construction phase 3) Avoidance of claims 4) Guarantees on construction/products
Time	1) Timely construction 2) Securing timely approvals 3) High speed of design cum construction 4) Early start 5) Minimal interference with the works

2.4.2 Objectives versus 'means to an end'

Some needs are mere 'means to an end' as opposed to being main objectives (Golub, 1997). For instance, the aspect of time in a construction project, is a means to an end as long as the specified product is achieved. Clients' requirements in respect of relations and lack of surprises, (see Table 2.2), are likewise means to an end. On the other hand, the attributes of aesthetics, quality and functionality are main objectives pertaining to a construction facility. The analyses of chapters 5, 6 and 8 employed the categorisation proffered by both O'Reilly (1987) and Golub (1997).

2.5 Characteristics of needs

Needs vary with individuals (Duffy, 1974; Albrecht and Bradford, 1990), inferring that clients and their expectations cannot be treated as unitary (Cherns and Bryant, 1984), but pluralistic (Sung, 1992; Green, 1996). Needs are known to complement and at times conflict with one another (Tatum and Fawcett, 1986; Ashworth, 1991; Ward et al., 1991). The irony is that the exact manner of the interrelationships between needs is unknown (Fishburn, 1964). Decision analysts, in this respect often assume independence of relationship between different objectives.

Another major characteristic of needs is that they vary over time even for a specific individual (Weihrich and Koontz, 1993). By this dynamism Fishburn (1964) suggested that, needs be discussed or studied in the context of a particular time frame. This suggestion is relevant to the type and reliability of the conclusions drawn from the investigation.

A complex dimension to varying needs is that the objectives of an individual, including construction clients, can change abruptly. This type of change has been attributed partly to bounded rationality wherein the clients might have failed to fully understand or grasp the entire magnitude of their requirements *ab initio* (Tversky, 1972). Designers and producers are thus faced with ambiguity and uncertainty in the course of project delivery as the client's requirements can suddenly change, making them revise or even throw their plans overboard (Globerson, 1997; Hillebrandt, 1984). Flexibility is thus needed in project design and delivery so that changes introduced by clients can be accommodated.

2.6 Laxity in the assessment of construction clients' needs

Though social scientists have evaluated community needs in the past, many decision makers still find the concept of needs-evaluation strange (Golub, 1997). Ironically, there is no indication on whether there is a unified approach to needs-assessment in construction practice.

The state of the art of construction clients' needs-assessment is described in literature as follows:

- the appraisal of clients' priorities has often been ignored (NEDO, 1988; Hughes, 1992c);
- construction professionals often adopt an over-simplistic view of clients and their needs (Beeston, 1984; Green, 1996);
- insufficient time is spent in developing client briefs (Carrington, 1979; Lera, 1984);
- little effort is made in developing client briefs (Procter and Bowen, 1992);
- project briefs are currently insufficient (Waters, 1979; Kelly et al., 1992).

These references suggest that construction clients' needs are improperly assessed. Notably construction products require large financial outlays (Allen, 1984; Hughes, 1992a), and, form a major part of clients' durable assets (Duffy, 1974; Chartered Institute of Building, 1980). The replacement, repair or refurbishment of construction products is very expensive (Briscoe, 1988), due to both direct and knock-on effects (Construction Industry Board, 1997). In view of its expensive characteristic, it will be prudent if construction production is planned, such that, satisfactory products are delivered to clients at the first instance.

One way in which the briefing process can be improved is to ensure that clients' needs are properly and accurately assessed. The accurate assessment of clients' needs will provide a better basis for exercising project control and ultimately ensuring clients' satisfaction (Mackinder and Marvin, 1982; Halpin et al., 1993). If clients' needs can be properly identified, then their achievement can be sought with more optimism, otherwise, clients' satisfaction will remain a random process (Langford et al., 1995).

Accurate identification of needs is seen as a pre-requisite of: good decision making (Fishburn, 1964; Burt, 1978), project planning (Sung, 1992; Harlow, 1992; Smith, 1994) and project control (Bennett, 1985). Determination of clients' needs as implied by these suggestions, has advantages for construction product delivery (Nahapiet and Nahapiet, 1985). One main advantage, which was portrayed in the earlier sections of this chapter, is that the level of clients' satisfaction with project outcomes would be optimised, if not maximised. Thus, it is not an understatement to say that construction clients' needs should be identified and met (Latham, 1994).

Marketing is a discipline in which the identification of needs has played a major role. A general reflection from marketing reveals that consumers are held in high esteem. The customer is known to say: "this is what I want, do not tell me what is good for me" (Halpin et al., 1993). This opinion of customers is favoured by suppliers, and, is used by them in keeping customers' desires in focus, and, in seeking for (best) ways of achieving them.

Any supplier or producer who can identify exactly what customers want and provide it can hold the leading edge in competition (Ohmae, 1988). It is thus not an understatement if it is suggested that construction producers adopt a culture and methodology for identifying their clients' needs. For according to Walker (1989), the construction industry should seek to establish clients' needs as the platter upon which their satisfaction would be based.

Different people and corporations attach different weights to different needs (McCuen, 1998). Thus, if (construction) products are to be provided to clients' optimum satisfaction, an understanding of each client's priorities is vital. It is in this light that the present research advocates for the formal assessment of clients' needs during briefing.

The initiative of establishing construction clients' needs may have to come from non-clients, especially professional advisers. This opinion is tendered because, some clients feel timid and at times inferior when expressing their project requirements (Potter, 1995). Further, some individuals are often unsure of what they want (Fishburn, 1964). Thus, Allen (1984) suggested that construction professionals should not accept clients' briefs on face value, but probe them to see how realistic they are. This suggestion calls for a form of assistance to clients where experts help them in specifying what they want.

One way of determining clients' requirements, as is being practised in big projects, is to use a team whose personnel have diverse skills. Designers, constructors, psychologists and other social scientists are constituted to help develop a brief (Farbstein, 1978). According to Green (1996), one way for getting to relate well with clients and understand their requirements properly is that brief formulators should seek to identify the metaphorical disposition of their clients. Some clients would subscribe to this idea as they are beginning to call for good relations with project participants (NEDO, 1988; and, CSSC, 1988).

2.7 The theoretical approach to the assessment of needs

Needs-assessment as used by social scientists is a measure of how much of what is needed (York, 1982). It has also been described as a process of ordering and prioritising community needs (McKillip, 1987). It is in the perspective of needs-assessment that techniques for identifying and evaluating communal needs have been proposed.

Needs are identified by questioning or interviewing the person(s) to whom these needs pertain (Lippitt, 1959; Fishburn, 1964; Alderfer, 1969; Lifson, 1972; Ohmae, 1988). Solomon and Evans (1992) showed that the use of interviews and questionnaires have both been employed in the past. Structured tools like checklists can be used with both questionnaires and interviews in the elicitation of needs (Bovis and Olson, 1984). This research used a checklist in identifying construction clients' project requirements. Its usage was adopted to save clients' time as they endeavoured to remember their needs in previous projects. It also enhanced the co-ordination of the collection and analysis of the data supplied by clients in this study.

One strategy, which has been used by behaviourists in the recording of client information, is the scoring of needs by clients on a rating scale (Hall and Nougaim, 1968). After identifying clients' construction requirements through a checklist this research asked them to rate their needs in terms of relative preferences.

Empirical studies suggest that satisfaction is associated more with important needs (Mobley and Locke, 1970; Walker, 1989). Thus, when construction clients' needs are not fully achieved (as reported by Cherns and Bryant, 1984; Atkin and Pothecary, 1994; etc.), it may be that constructors have failed short of achieving the clients' predominant needs. Thus, after identifying a set of needs for a client, they must be evaluated to further identify those that are critical.

According to Golub (1997), techniques, which are useful in the evaluation of needs, are:

1. direct weighting;
2. swing weighting; and,
3. equivalence lottery methods.

These trio, are differentiated below.

2.7.1 Direct weighting

First the desired needs of a client are listed in order of priority. Then, the most desired need is chosen as an anchor and, the relative importance of the subsequent needs, are elicited with respect to this anchor. By aggregating the relative importance of needs and equating it to 100, the relative weight of each need can be determined by computations (Golub, 1997).

Implementation of this method requires close supervision to ensure that the assessment is done correctly. Therefore the adoption of this method was impracticable in the present research because the clients from whom information were solicited were well dispersed all over The UK such that the researcher could not physically monitor all of them while their needs were being assessed.

2.7.2 Swing weighting

In this method, the identified needs are first prioritised or ranked, then the most desired need is initially anchored as the 'best-on-one' outcome. By assuming a 'worst-on-all' outcome for the least preferred need, the amount of improvement needed to move from the worst-on-all to the best-on-one outcome is assessed and noted.

Next, the second most desired need is anchored as the best-on-one outcome, and similarly, the amount of improvement needed to move from the worst-on-all outcome to the latest best-on-one anchor is established. Expectedly, the amount of improvement valued in the second step is less than the first. So, the second amount is expressed as a fraction of the first.

The procedure is repeated for the other needs in descending order of priority. In the end, the sum of all the amounts of improvement is equated to 100 where, the various amounts of needs-preferences can be solved for, through simultaneous equations, as in the direct weighting method. The impracticability of this method follows from the discussion of sub-section 2.7.1.

2.7.3 Equivalence lottery method

The difference between the best-on-all and worst-on-all outcomes is successively assessed for all needs as in the swing weighting method. In this case however, the best-on-all outcome is assigned a utility of 100 while the worst-on-all outcome is assigned a utility of zero. A trade-off option is next considered for each need where the decision maker is indifferent between the best-on-all option on the one hand, and a combination of the best-on-all option with probability p, and, the worst-on-all outcome with associated probability of one minus p. This combination is shown in Figure 2.1.

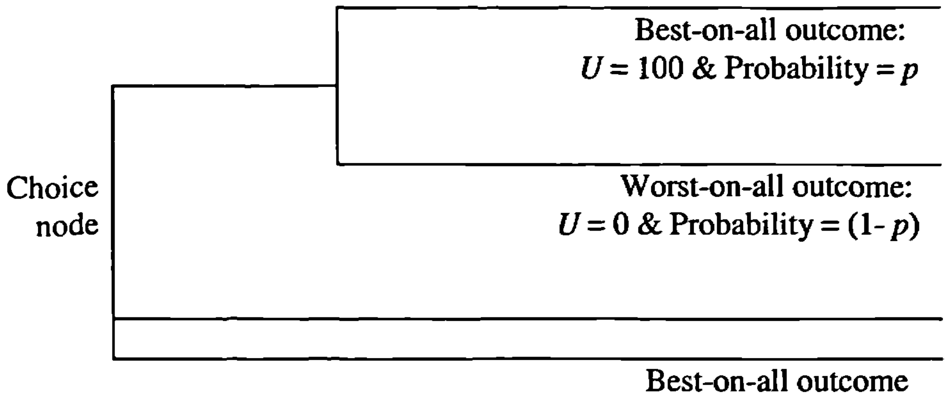


Figure 2.1 : Comparison of options

The relative utility of the trade-off shown in Figure 2.1 is assessed where, the weighting of a need is calculated by the formula:

$$W_i = \frac{U_i}{\Sigma U_i}, \text{ wherein } U \text{ refers to utility (value).}$$

The equivalence lottery method is more complicated, and, the amount of time and effort it demands from the clients whose needs are being scaled is also greater than the previous two methods. Since these previous two methods were not adopted for this research, the equivalent lottery method was likewise not selected. Another technique, which was eventually adopted, is introduced in Section 2.8.

2.7.4 Setbacks with the needs-assessment techniques

The approach used by social scientists, as reviewed above, has concentrated on studying the requirements of groups rather than individuals. More so, despite the availability of the foregoing evaluation techniques, experience rather than scientific rigour has prevailed in the assessment of human needs (Harlow, 1992). It is also noted that the state of the art in human needs assessment has remained underdeveloped (Sung, 1992).

A methodology for assessing the needs of both groups and individuals would be more versatile. One such versatile technique, employed by psychologists, is the method of paired-comparisons. Its principles were adopted for the present research because, the amount of participation that it demands from client-groups is relatively less. This technique also accounts for inconsistent preferences expressed by the clients.

2.8 Adoption of 'paired comparisons' for scaling clients' needs

The desire of needs comes from human minds and is thus, not a tangible object. So, no physical instrument can effectively measure a given amount of desire. A psychological perspective sheds more light on the magnitude with which needs are desired (Rust and Golombok, 1989; McGuire and Davison, 1991; 1995). With this understanding a psychometric instrument was sought for perceiving construction clients' values (i.e., preferences; levels of desire; etc.).

Amongst the psychometric scales which are available for quantifying mental stimuli, the method of 'paired-comparisons' was adopted because, "it is favourable" (Witkin, 1984), and, it has been successfully used (Baird and Noma, 1978). This choice acknowledges without discrediting other scaling techniques, which could be used. Such other techniques include (Guilford, 1954): 1) Rank scaling; 2) Use of rating scales; 3) Method of minimal changes; etc. Since the chosen method of paired-comparisons is not popular in construction texts or applications, its principles were described (in Chapter 7) prior to its application. The following sub-section gives a preview of the technique.

2.8.1 A background perspective of the technique of paired-comparisons

The method of paired-comparisons was developed by Thurstone (1927) and was originally construed as a means of measuring physical stimuli like weights. However, the technique has since gained a wider usage and has been applied in measurements pertaining to: taste-testing, consumer tests, colour comparisons, etc. (David, 1969). By inference, human values can be measured by this scaling technique.

Fechner (*1860*) is acknowledged to have pioneered psychophysical experiments, way back in the 19th century when he investigated the aesthetical values of different objects using pair-comparisons. However it was Thurstone who fully developed its theoretical principles, thereby popularising the concept (Bock and Jones, 1968; David, 1969).

Essentially the pair-comparisons technique involves presenting pairs of stimuli successively to a judge or judges, and asking them to make a choice, on each occasion, as to which stimulus is preferred in a paired combination (McGuire and Davison, 1991). The information generated from the responses is analytically computed such that the stimuli can be represented on a unidimensional continuum.

Thurstone used the normal (orgive) distribution in deriving a solution to paired comparisons data. Later, Bradley and Terry (1952) and Luce (1959) employed probit analysis in deriving solutions to similar data. This later approach is often referred to, as the 'Bradley-Terry-Luce' (BTL) model (McGuire and Davison, 1991). The scaling of stimuli by the BTL model gives values on a ratio scale while the Thurstonian model gives its results on an interval scale (Coombs, 1964). Measuring stimuli via either the normal orgive or probit function gives equivalent results which, are virtually linearly related (Torgerson, 1958). Either of them could thus be used. Between the duo, Thurstone's model was chosen for the present research because of the following three reasons:

1. More literature could be found on it quickly than on the BTL model;
2. Thurstone's approach is acknowledged by most scholars to be popular; and,
3. Thurstone's model is easier to use.

2.8.2 Appropriateness of paired-comparisons for measuring the values of construction clients

Some construction clients' needs are latent (Potter, 1995; Smith, 1994), and, it takes probing to both identify latent needs and how much they are desired (Albrecht and Bradford, 1990). The channels employed by scaling instruments for probing include (Lawless, 1979):

- observations;
- projective-techniques;
- sorting; and,

- self inventories.

Amongst these, self-inventories provide a more valid approach for measuring human motives and personal conceptions (Nunnally, 1978). Based on this suggestion, self-inventories were adopted in the elicitation of clients' needs in this research.

Self inventories can use rating scales, statements-ranking or comparative - judgements as means of eliciting information. The rating scales are not very efficient in soliciting information regarding mental stimuli (Mobley and Locke, 1970). According to Mobley and Locke, discussions with some subjects whom they studied indicated that relaying information regarding value preferences demands introspection. Some people are not competent introspects, hence they may not be able to decipher their exact preferences, at least, not unaided. Thus the usage of rating scales in eliciting desires might present difficulties and generate unreliable information.

On the other hand, it has been suggested that the technique of comparative-judgements performs better in producing more valid results (Edwin and Locke, 1970; Dachler and Hulin, 1969); and, is popular (Allen and Yen, 1979). This understanding swayed this research into using comparative-judgements in the elicitation of construction clients' values concerning their projects.

The response demanded by paired-comparisons in the elicitation of data is such that clients have to discriminate between needs on the basis of their preference values. Inasmuch as a client is allowed to be (minimally) indifferent in the choices, bias in the use of this method is kept minimal. Further details concerning the principles and applicability of this technique are discussed in chapter 7.

2.9 The way forward

The way forward towards ensuring clients' optimum satisfaction with construction production would involve the development of strategies, principles and theories that can ensure the accurate assessment, pursuit and achievement of their needs. It is paved by these remarks:

- project objectives should be clearly stated and rigidly met (Flanagan et al., 1986);
- it should be noted that clients' roles are crucial in the development of project objectives (Bennett, 1985; Building and Civil Engineering EDCs, 1975); and,
- there is a need to employ more sophistication (Green, 1996).

The development of more appropriate project briefs in the light of the foregoing recommendations would involve concerted efforts aimed at identifying clients' needs and the values attached to them. If so done, uncertainties in various aspects of project delivery will be curtailed (Building and Civil Engineering EDCs, 1975).

At least, three things can be deduced from the discussions of this chapter, which are:

- Construction clients' needs are (sometimes) not properly evaluated;
- There is a need for the proper identification of clients' project requirements; and,
- Identified requirements have to be prioritised and achieved (in order of importance) before clients' satisfaction with construction outcomes can be optimised.

Assessing clients' needs can be difficult though (Roberts, 1992), partly because of their pluralistic nature (Sung, 1992). An indication from Duffy (1974) is that "research on buildings and people is difficult because, many other factors intervene which diminish the importance of buildings in the user's eyes". The achievement of construction clients' needs could be difficult due, *inta alia*, to complexities in the clients' requirements. This complexity provides an opportunity for research aimed at making construction production less ambiguous, for according to Leedy (1993), one purpose of research is to make life easier. Although clients' needs are numerous and complex a means of evaluating them more accurately and with relative ease was explored in this research.

The level of accuracy that can be achieved in any needs-assessment would depend on the type and quality of information available. Thus, any assessment of needs must consider the quality of information, which is to be supplied by the clients concerned.

This research considered the quality of information supplied by construction clients (in chapter 5) prior to evaluating their preferences.

2.10 Summary

This chapter defined and compiled construction clients' needs. The meanings of needs that were generated from literature were also categorised into the eight generic needs of aesthetics, economy, functionality, quality, relations, safety, commitment (i.e. lack of surprises) and time. The discussions did show that construction clients sometimes fall short of identifying what they want. It thus seems logical that construction professionals should help clients in assessing their needs rather than leaving the task to the clients themselves, who could be naive.

However, the state of the art concerning needs assessment in construction briefing is yet to be perfected. Although literature agrees that construction clients' needs should be evaluated, there is no standardised theory-backed suggestion as to how that should be done, and, there is no indication whether a uniform procedure for assessing clients' needs exists or not.

Having reviewed theoretical techniques for evaluating needs, this research in its exploratory pursuit, adopted the psychometric technique of 'paired-comparisons' as a means of measuring construction clients' needs. The rationale is that, clients' needs, being synonymous with project objectives should be evaluated, targeted and met where, more sophistication has been advocated.

CHAPTER THREE

CLIENTS' NEEDS AND DECISION ANALYSIS

CHAPTER THREE : CLIENTS' NEEDS AND DECISION ANALYSIS

3.1 Introduction

In chapter 2, clients' needs were defined and, literature was reviewed to show that needs are inadequately evaluated during briefing. Following on, this chapter dwells on the usefulness of needs-assessment. Table 2.1 showed a compilation of clients' needs pertaining to different aspects of construction delivery (like: design, procurement, etc.). These needs provide the basis upon which project decisions are made. Be it design development, contractor selection, identification of procurement strategy, writing of specifications, etc., the client's needs are the yardstick upon which the diverse project decisions will be made. If the client wants a round-shaped multi-storey building with glazed walls, so be it. The priorities attached to a set of needs by a client provide a basis for choosing one project solution over the other(s).

Since clients' needs and their evaluation enhance decision making, a review of literature on decision making was made to support the discussions of chapter 2, and is reported in this chapter. Theoretical decision analysis is reviewed because it emphasises the usage of needs as choice criteria. The role of clients' needs in decision making is thus explained in this chapter.

The chapter starts with an overview of decision making in general and proceeds to discuss the 'normative' and 'descriptive' techniques employed in decision analysis together with their respective analytical models. The chapter ends by casting a retrospective view at decision making in construction practice using the hindsight of concepts and issues discussed. The critique in this chapter is kept minimal since the focus of the research was on clients' needs and not decision making.

3.2 Decision making

Decisions are characterised by the availability of alternative courses of action (Savage, 1954b; Keeney, 1977). If there are no alternatives to a problem, then there is no decision to be made (York, 1982). Essentially then, decision making involves choosing from amongst alternative solutions. Examples of options necessitating a decision in construction undertakings are:

- there may be alternative designs to be considered before one is eventually selected - using the client's functional and aesthetical values;
- three types of foundations may be appropriate for a desired building, where one can be chosen using the time and price limits specified by the client;
- in selective tendering, three to five contractors are often considered, after some form of pre-qualification, upon which one is eventually selected to undertake the project as the main contractor;
- three procurement alternatives may be applicable to a project of which one would have to be selected;
- two alternative structural forms (steel and concrete) may both be adequate for a building. The priorities attached to durability and cost by the client could be used in choosing one of these alternatives for the building project.

From these examples, it can be deduced that decision making is both relevant and applicable in the delivery of construction projects.

O'Shaughnessy (1972) acknowledges that in decision making, the best course of action is usually known, that is, some decisions are straightforward. Also notable is that, decisions can be made intuitively (Hogarth, 1980), partially rendering decision making a high-level thought process (Evans et al., 1993). Further, some rare problems are 'close-ended', having only one rightful solution (Smith et al., 1998).

However when the selection of one from many courses of action is not straightforward the task becomes arduous. It is in respect of such difficulty that analytical aids have been developed for identifying the best course of action in decision scenarios. Analytical decision making is not a snap action, but a process involving 4 steps, which are (McGrew and Wilson, 1982; Weihrich and Koontz, 1993; Flanagan and Norman, 1993):

1. Problem definition;
2. Identification of most feasible alternative solutions to the problem;
3. Analyses of the few most viable alternative solutions; and,
4. Finally choosing the best course of action and implementing it.

In line with the foregoing steps a typical decision scenario would be represented in a decision table, as in Figure 3.1.

		States of nature: $X_1, X_2, X_3, \ldots \ldots, X_n$
	A_1	$C_{11}, C_{12}, C_{13}, \ldots\ldots\ldots, C_{1n}\}$
	A_2	$C_{21}, C_{22}, C_{23}, \ldots\ldots\ldots, C_{2n}\}$
Options:		
	A_i	$C_{i1}, C_{i2}, C_{i3}, \ldots, C_{ij}, \ldots, C_{in}\}$
	A_n	$C_{n1}, C_{n2}, C_{n3}, \ldots\ldots\ldots\ldots, C_{nn}\}$

(Consequence = C_{ij})

Figure 3.1 Depiction of a decision scenario
(*Source: Luce and Raiffa, 1957).*

An alternative form for representing a decision scenario is the 'decision tree' (French, 1989). Whilst decision tables are static, representing one decision or an aspect of a decision, decision trees are dynamic, representing sequential or multi-stage decisions. The choice of one form of representation over the other is circumspect. The use of a decision table in this communication was chosen because, it portrays the role of clients' needs more than a decision tree. The terminology employed in Figure 3.1 is now explained.

3.2.1 Options

Decision options are the most viable alternative courses of action that can lead to problem resolution. Having defined a problem, several alternative solutions to it are identified upon which a few are shortlisted as being the most viable. It is these selected few options that are taken unto the analytical phase.

For a structured decision, the options should be exhaustive and mutually exclusive (Lindley, 1971). Decision analysts who are specialists should assist in identifying the most viable options (Fishburn, 1964), as the clients on whose behalf decisions are analysed may not be able to determine the best options.

3.2.2 States of nature

States of nature refer to the circumstances (or environment) overshadowing a particular decision (Almeda and Bohoris, 1995). For example, inclement weather is a state of nature that could interfere with construction production. The states of nature are structured to be mutually exclusive, and, only one of them would eclipse the course of any selected decision option (French, 1989).

Decision analysts can also assist a decision maker in identifying the different states of nature associated with a particular decision and their likely impact on the outcomes of the respective different options (O'Shaughnessy, 1972). This however does not infer a direct control of these states of nature as they are usually beyond the influence of decision analysts (Savage, 1954).

3.2.3 Consequences

Different decision options, usually but not necessarily, yield different outcomes (consequences), which, are expressible in terms of either qualitative descriptions or numerical values like monetary value, time-scale, etc. (Lifson, 1972). The influence of the states of nature on the options compounds the variability of the eventual outcomes (Savage, 1954). Also, the effect of consequences could be immediate or long-term (O'Shaughnessy, 1972).

It is a comparative analysis of the consequences of alternative options that leads to the identification of the best option that would optimise the achievement of any specified set of (client's) needs (Fishburn, 1964; O'Shaughnessy, 1972). Thus, the consequences pertaining to different options of a particular decision have to be quantified, weighed and ranked in proportion to their degree of importance before the best option can be identified (Schutzer, 1991). This implies that some form of evaluation is necessary in decision making.

It was earlier expressed that decision analysis may not be straightforward. This is partly so because, at the time a decisions is being made, the magnitudes of the consequences of the different options may be unknown (Bell et al., 1977). This introduces uncertainty in the decision making process. Depending on if the eventual consequences of a decision are (un)known, the decision making process is classified into three, as either:

1. Decision making under conditions of certainty;
2. Decision making under conditions of risk; or,
3. Decision making under conditions of uncertainty.

3.2.3.1 Decision making under conditions of certainty

Under this type of decision making each option is known to invariably lead to a specific single outcome (Lifson, 1972; Luce and Raiffa, 1957), and, there is accurate knowledge as to the exact magnitude of the outcome of each option (Davis and Olson, 1984). Certainty of outcome renders this type of decision making a fairly straightforward matter. Since the different outcomes are known precisely, choice can easily be made on any given criterion. In this light decision making under conditions of certainty is sometimes treated as a maximisation problem where the achievement of a given criterion is optimised.

3.2.3.2 Decision making under conditions of risk

Here, each decision option leads to a specific set of multiple and variable outcomes where each outcome is hinged on the intervening state(s) of nature. However, the probability of occurrence of each state of nature, and hence outcome, is either known or can be estimated reliably (Lifson, 1972; Luce and Raiffa, 1957). In terms of analytical effort, decision making under risk is akin to that under conditions of certainty except that, instead of maximising outcomes, expected outcomes are optimised where, an expected outcome is the product of its magnitude and its corresponding probability of occurrence (Davis and Olson, 1984).

3.2.3.3 Decision making under conditions of uncertainty

These types of decisions are similar to those under risk, except that the probabilities of occurrence of the states of nature are unknown or are meaningless (Davis and Olson, 1984; Lifson, 1972; Luce and Raiffa, 1957). Conditions of absolute uncertainty are rare, thus, most uncertain outcomes are often reduced to risky consequences (Moore and Thomas, 1977; Keeney, 1977). In doing so estimated probabilities are assigned to the various states of nature that underpin the different outcomes (Davis and Olson, 1984; Lindley, 1971; Coombs et al., 1970). The assignment of probabilities to these type of outcomes enhances their analysis as in the risky situation of Section 2.2.3.2 (Davis and Olson, 1984).

Being that uncertainty is mathematically expressible as risk, Keeney (1977) and Luce and Raiffa (1957) considered a fourth and variant type of decision making described as 'decision making under risk and uncertainty'. In this regard, the magnitudes of the consequences of a decision are assessed and, their probabilities of occurrence are estimated. These two are considered in tandem for the purpose of comparing the alternative options.

3.2.4 Goals

The goals of a decision maker are the targets which a decision is invariably expected to achieve through the selection of an option or series of options. Other terms, which are synonymous with goals, are (Fishburn, 1964): **needs**, aims, objectives and purposes. Human choice is generally described as goal-seeking (Graham, 1980). Goals thus influence decision making (Brown and Scarbrough, 1993) as they are the yardstick for evaluating the relative worth of different options (Leigh, 1983).

Sometimes an outcome is expressible in terms of a goal (Turban, 1993). For example, construction time and price could both be used to describe project outcomes, so could they be used by clients to define their needs concerning certain projects. Goals could either be concrete or abstract things (MacCrimmon and Wehrung, 1977). For example, the price and duration for constructing a building are relatively concrete while its aesthetics is more subjective.

The goals to be employed in any decision must be relevant, inclusive, non-overlapping and operational (Lindley, 1971; Bell et al., 1977). Some other characteristics of goals combine to compound the difficulty of decision analysis. According to Bell et al. (1977) decision making goals are often multiple and are not given a priori - warranting their accurate identification. Also, some or all goals of a particular decision could be incommensurable, i.e., quantifiable in different units (Bell et al., 1977; Almeda and Bohoris, 1995).

It is not the responsibility of decision analysts to tell decision makers what their goals should be, but, to help them in verifying what they want and in seeking for best ways of achieving them (Fishburn, 1964). The role of professionals in helping decision makers determine their needs is reinforced by an argument in chapter 1 where it was explained that some (construction) clients do not know what they want. This research therefore dwelled on developing a basis, which could be used for identifying or verifying construction clients' needs prior to project decision making. This quest has been advocated by: Construction Industry Board (1997); O'Reilly, (1987); and, Brown and Scarbrough (1993).

The level of importance attached to different goals by different clients varies. The relative desires attached to goals by a decision maker should be quantified (Leigh, 1983). Even the psychological and intangible goals must be accounted for otherwise the result of an analysis would be distorted leading to bad decisions (Bell et al., 1977; and Ohmae, 1988). Good or bad decision making does not necessarily equate with best outcomes, but rests on the understanding that on the basis of the information available at the time of choice, the best judgement was made in the light of goals considered and outcomes foreseen (Baron, 1994; Clemen, 1991).

The inference to be drawn from some of the foregoing paragraphs is that by evaluating construction clients' needs with more accuracy, decision solutions that match their particular requirements can subsequently be sought (Higgin and Jessop, 1965). In this regard, MacCrimmon and Wehrung (1977) opined that a quantification of goals on a ratio or interval scale would make decision analysis easy. This opinion was heeded in shaping the course of this research. Also considered was the advice that all intangible attributes concerning a decision be considered (Bell et al., 1977).

Sometimes the achievement of the different goals of a decision could conflict with one another (Graham, 1980; Schutzer, 1991), implying that the numerous goals of a client may not all be achievable (O'Shaughnessy, 1972; Turban, 1993). The more there are goals pertaining a decision, the more chances some of them would conflict with one another. Conflicting goals call for sacrifice where, the achievement of one or more goal(s) could be traded-off for others (O'Shaughnessy, 1972; MacCrimmon and Wehrung, 1977). Choice in decision analysis may thus involve trading-off some client-goals (Hogarth, 1980).

The trading-off of goals is especially possible if they are quantifiable. Through quantification goals which are least desired could be sacrificed, if need be, for the sake of achieving the more highly coveted ones (Kelly et al., 1992; Masterman, 1992; Day, 1994). When goals have to be traded-off this way, they are seen to complement one another (Turban, 1993).

3.3 Decision Analysis

It would seem that decision analysis is used in literature to refer to both the process and the techniques employed in evaluating the viability of different decision options. The phrase is used in this communication in reference to the analytical techniques employed in decision making. Decision analysis is especially valuable for decision making under conditions of risk and uncertainty where different combinations of consequences and probabilities have to be evaluated (Kaufman and Thomas, 1977; Flanagan and Norman, 1993).

The main aim of decision analysis in the course of decision making is to identify the option with the greatest potential of achieving the decision maker's goals (Bell et al., 1977; Baron, 1994). In this regard the ultimate option identified by evaluation as the best is expected to satisfy the prevalent needs of the client optimally (Lifson, 1972; MacCrimmon and Wehrung, 1977; Hogarth, 1980; Ohmae, 1988). The necessitating feature for analytical decision making is indecision on the part of decision maker(s) which, is mainly orchestrated by problem complexity (Fishburn, 1964).

Complexity could imply that the problem being analysed might either be unstructured or incomprehensible. Other attributes of problem complexity include (Coombs et al., 1970; MacCrimmon and Wehrung, 1977):

- doubt as to which alternative to select - especially when they have similar worth;
- conflicting objectives with which to weigh the decision options (see; Section 2.2.4); and,
- uncertainty with respect to the occurrence of outcomes

Amongst these causes of problem complexity, 'uncertainty of outcomes' is seen by Lindley (1971) to be a predominant reason for necessitating decision analysis. Uncertainty of decision outcomes can arise from two sources, which are inability to estimate the (Coombs et al., 1970): 1) full impact of the states of nature surrounding the courses of action; and, 2) the magnitude of the consequences of the alternative decision options.

3.3.1 Axioms of decision analysis

Decision analysis is underpinned on certain axioms, which are (Schutzer, 1991):

1. The decision maker is an individual;
2. Choices are manageable;
3. Goals are clear, unambiguous and constant; and,
4. Consequences of decision options are directly measurable.

These axioms infer a rational approach in decision analysis.

3.3.2 Types of decision analysis techniques

Decision analysis techniques are numerous, and, are of two broad types: normative and descriptive (Hammond et al., 1980; Slovic et al., 1977). The normative techniques are prescriptive in that they specify a course of action to the decision maker (Slovic et al., 1977). They are used to direct the decision maker's action (Bell et al., 1977; Hogarth, 1980). These techniques have been developed mostly by economists, mathematicians and management scientists (Davis and Olson, 1984), and, are especially useful for decision making under conditions of uncertainty cum risk.

The descriptive techniques on the other hand, are explanatory and their emphasis is on how decisions are actually made (Coombs et al., 1970). They also try to explain how decisions depart from the strict rationality of the normative approach (Hammond et al., 1980). The theory of descriptive decision making was (and is being) developed mostly by psychologists and other behavioural scientists who see its contributions to be more practicable and acceptable (Davis and Olson, 1984). The association of normative or descriptive decision making to some academic disciplines is loose and not strict, as there are overlaps (Hammond, et al. 1980; Almeda and Bohoris, 1995).

Descriptive decision analysis can be considered as an extension of normative decision analysis, however the duo are distinct as their respective emphases, backgrounds and approaches differ (Becker and McClintock, 1967). While descriptive decision analysis is concerned with explaining client-goals/values and how they influence choice behaviour, normative decision analysis focuses more on the consequences of the decision options and their likelihood of occurrence (Slovic et al., 1977; Bell et al., 1977; Hogarth, 1980).

In addition to the foregoing two, there is a third and less emphasised type of decision analysis, referred to by Leigh (1983) as "mixed-scanning". This type of decision analysis combines features from both the normative and descriptive approaches. Many scholars have not reported on this mixed-strategy and hence the full theory behind it was not discussed in the present communication, as it is not yet fully developed like the preceding two.

3.4 Normative decision analysis

Approached from the perspective of decision making under risk, the principle of normative decision analysis is that, the magnitudes of the consequences of alternative decision options are assessed, and the corresponding probabilities of occurrence of the states of nature that impact on them are established or estimated, as the case may be. The product of these two for each consequence is used in comparing the alternative options.

There are different methods by which the decision options could be compared in the normative arena. These include the principles of: minimax; maximin; maximax; regret; probability; expected monetary value; and, utility (Leigh, 1983). Others are Bayes' rule; and, regression analysis (Schutzer, 1991). These different principles are explained below not necessarily in that order.

3.4.1 Subjective Expected Utility

Subjective expected utility uses 'utility' in valuing the magnitudes of the consequences of alternative options, and, subjective probability in assessing the likelihood of occurrence of intervening states of nature (Lindley, 1971). The notion of utility was used by Von Neumann and Morgenstern, (1944), to represent the preferences of individuals. Thus, utility has been referenced as (Baron, 1988): "desirability" or "subjective value".

Modern utility theory was developed by Ramsay (1930) and furthered by Von Neumann and Morgenstern (1944). Prior to the Ramsay and Von-Neumann/Morgenstern developments, utility theory was considered by economists in the classical sense. Modern utility theory differs from the utility of classical economists in that it considers the attitude of the decision maker towards risks (French, 1989). Although other variants of utility theory have been proposed (Fishburn, 1964), the Von Neumann-Morgenstern postulates seem to be popular and thus, their concept is often referenced by decision theorists (Bell et al., 1977).

Von Neumann and Morgenstern (1944, 1953) showed that, given a set of decision options and if a person is able to show preferences between all pairs of options, then utility values can be associated with the options such that, provided one is consistent in taste and acts in accordance with that taste, then (s)he would be guided by expected utility value. The supposition is that in any given decision making situation, a rational decision maker would have a preference ordering 'utility function' (UF) and, would act or make decisions in a bid to maximise expected utility (Keeney, 1977; Slovic et al., 1977; Hull et al., 1977).

The use of subjective expected utility warrants some form of measurement to determine the utility values of different decision options. Utility values are indeed measurable, and, Baron (1988); Flanagan and Norman, (1993); and, Hull et al. (1977) amongst others, have described how this can be done. Utility values are measured with respect to an arbitrary origin and unit of measurement (Keeney, 1977).

Having measured the utilities of respective decision options, UF then assigns values in the manner $u(A) > u(B)$, if and only if consequence A is preferred to consequence B, where, $u(A)$ means the utility value of consequence A. The aggregate expected utility (value) of a decision option is thus (Keeney, 1977):

$$EU_i = \sum_i p(i)u(i), \text{ where:}$$

i is the i-th option and/or outcome;
p its probability of occurrence; and,
u its utility value.

In a given decision situation, the EUs of the different options are computed in accordance with the foregoing formula, and, maximisation of subjective expected utility infers that the option with the highest aggregate expected utility value be selected. Maximisation of utility scores is used as yardstick of choice in decision making under conditions of certainty while expected utility is utilised under risky situations (Edwards, 1954).

Since utility values are assigned in conformity with clients' preferences (French, 1989), the option with highest (subjective) expected utility should satisfy the client optimally. By this, it is assumed that the expected score (utility) of each consequence is equivalent to its true value as perceived by the decision maker (Savage, 1954). Maximisation of subjective expected utility by the foregoing approach is thus an idealistic approach to problem resolution (Bell et al., 1977).

3.4.1.1 Multi-attribute utility theory

The consequences of some decision options are multi-attributed (Lifson, 1972; Keeney, 1977; Schutzer, 1991). Multi-attribute utility theory (MAUT) which is an extension of subjective expected utility, is applicable to such decision situations (Baron, 1988). With MAUT the cumulative utility score of a decision consequence, where multi-attributed, is ascertained by aggregating the proportionate scores of all its constituents. MAUT thus proffers that one computes for each option, weighted utilities summed across the different attributes (Slovic et al., 1977). That is,

$$\mathrm{MAU}_n = \sum_n w_i . u_{in}$$

Where: MAU is multi-attribute utility;

w_i is the relative weighting of the i-th attribute; and,

u_{in} is the utility of option n on attribute i.

MAU_n is the general formula for combining multi-attribute utilities. Variants of this formula that account for uncertainty, multiplicativity instead of additivity, time factors etc., can be employed (Slovic et al., 1977). Other than that, the remaining aspects of MAUT are the same with the considerations of subjective expected utility.

3.4.1.2 Advantages of utility theory

The advantages of employing utility scores in decision analysis are:

1. Subjective expected utility and MAUT provide an objective basis for comparing decision options, and,
2. MAUT enables decision analysts to evaluate (indirectly) the aggregate scores of multiple goals.

3.4.1.3 Disadvantages of utility theory

Utility considerations have their setbacks, which include:

1. Expected utility introduces probability in its computations, thereby reducing the eventual consequences to forecasts instead of actual outcomes;
2. The computed utility values are only assumed to equate with client values - which may not be so; and,
3. The process of establishing utility values is cumbersome and time-consuming.

3.4.2 The minimax criterion

The minimax criterion is a principle of choice based on Wald's (1950) proposition. Its concept has been explained by Savage (1954). The concept is termed 'minimax', meaning, **mini**mise the **maxi**mum loss. Given that a certain state of nature obtains, the expected consequence of an option is ascertained. This is contrasted with the maximum possible outcome to give the maximum (expected) loss attributable to that option. The expected losses associated with the other decision options are likewise ascertained upon which minimax suggests that the option with the least loss be preferred.

As a heuristic approach, this technique provides a saving on time and computational effort when compared with the use of utility. However it disregards the likelihood of occurrence of possible states of nature and their potential impact on eventual consequences. Thus, results obtained with this technique could be incomplete, and, are definitely unprofitable for decisions where the impact of the states of nature is strong and certain.

Allied techniques of the minimax principle, which are discussed below, follow the same pattern of consideration. The reviews are referenced from Coombs et al. (1970) who explained that these other heuristics are often employed in the light of ignorance concerning the likelihood of occurrence of events. Except mentioned, these allied techniques share the same (dis)advantages with the minimax criterion.

3.4.3 The maximin criterion

This is a pessimistic approach in which the worst (minimum) possible outcome of each option is initially evaluated. From these outcomes the maximin criterion simply recommends that the best (maximum) be chosen. Being pessimistic the technique is useful in situations where great caution is required. The technique thus appeals to people who are risk-averse and to those who are willing to accept less optimal outcomes by treading on soft grounds.

3.4.4 The maximax criterion

This is an optimistic approach in that it first selects the best consequence of each decision option, and then chooses the very best from them. Risk-prone decision makers would likely use this approach. Its privilege is that, if all goes well, the very best option would be obtained. The disadvantage with this approach is that, states of nature could impact on the chosen course of action to render the decision made, a regrettable one. In the face of accountability, decision analysts may find it difficult to justify bad decisions that were made using this technique.

3.4.5 The regret criterion

The regret criterion considers the opportunity costs (regret) of all options and selects the consequence with the least regret. The advantages and disadvantages of this technique are the same with those of the minimax criterion as their principles are similar.

3.4.6 The expected monetary value criterion

The objective of this approach is to maximise the single criterion of money (Golub, 1997). Monetary values are attached to the alternative decision options and, choice is based on the option with maximum monetary value or least expenditure. In risky situations expected monetary value is employed as with utility theory except that monetary value replaces utility in the formula that was given in Section 3.4.1.

Where the outcomes of decision options are certain, this technique provides a yardstick of choice that is marketable to clients and the public, as cost/price is inadvertently justified. The evaluations and comparisons of this technique are also relatively straightforward, as it is easy to price or estimate the worth of different outcomes.

The disadvantage with this technique however, is the inherent assumption, albeit rightly or wrongly, that cost is of prime value to the decision maker. Even if cost were of prime importance to the client, other attributes of prime value to the client are apparently ignored by this heuristic.

3.4.7 The probability criterion

Here the likelihood of occurrence of consequences is mainly used as the basis of choice. In using this criterion, the probability of occurrence of a consequence, is predicted from the probabilities of related events, where Bayes' rule could be used. Given that a related consequence 'A' has occurred and 'B' and 'C' are potential consequences; the likelihood of B or C occurring is compared by the ratio:

$$P(B/A)/P(C/A), \text{ where; 'P' denotes probability.}$$

Using the ratio form of Bayes rule, the above fraction can be equated as (Pfeiffer and Schum, 1973):

$$P(B/A)/P(C/A) = P(B).P(A/B) / P(C).P(A/C)$$

The left-hand-side of the equation denotes the odds for B over C. If this ratio exceeds a specified threshold outcome 'B' is favoured. The higher the threshold value, the lesser the chances of making error in the decision.

The probability criterion is employed in situations where the consequences of decisions are not directly measurable (Schutzer, 1991). It is thus suitable for situations where the consequences of the different options are relatively equal. Since probability does not necessarily equate with certainty, the option predicted as best by this technique may not turn out to be best after the states of nature have impacted on the different decision options. The probabilistic disposition of this technique aligns it with optimal and not actual decision making.

3.4.8 Regression analysis

A regression equation is of the form:

$$Y = aX_1 + bX_2 + cX_3 + \ldots + nX_n, \text{ where:}$$

Y is an outcome;

X_is are attributes (predictors) of this outcome; and,

$a,b,c,$ etc. are discriminant weights.

The attributes of each decision option are scaled and weighed in accordance with their importance, and, the option with the resultant highest outcome is deemed to be preferable. Schutzer (1991) reports that regression models have been used, in a feedback process, to check the accuracy of decisions made by professionals.

This technique allows several client-values to be considered and weighed in concordant proportion with their desires. However, for this technique to be efficient, the certainty of outcomes has to be accounted for, and, the magnitudes of the discriminant weights have to be accurate or reflect true client-values, which may be unknown. The technique thus provides a basis for retrospective accountability where the goodness or badness of previous decisions can be assessed. This (dis)advantage is reinforced in situations where the discriminant weights can be ascertained more accurately after project completion.

3.4.9 Miscellaneous criteria

Some quantitative techniques in operational research have been suggested as being applicable in decision analysis, however these are not usually given a coverage in decision making texts. Suffice to mention them only, as including (Davis and Olson, 1984): Systems of equations; Linear programming; Integer programming; Dynamic programming; Queuing models; Inventory models; Capital budgeting analysis; and, break-even analysis.

The foregoing listing suggests that the number of techniques applicable for decision making could be endless. While some decisions may be replicable some others are quite unique. The diversity of decision analysis techniques equips the analysts with tools, which are handy to handle different circumstances.

3.4.10 A retrospective view of normative decision analysis

Normative decision analysis could be highly probabilistic (Luce, 1959). By this characteristic, it is concerned with optimal and not actual decision making (Coombs et al., 1970). Amongst the normative decision analysis techniques that have been developed, Fishburn (1964) explains that two of them stand out visibly, namely:

1. the Von Neumann and Morgenstern (1947) utility approach; and,
2. Wald's (1950) minimax principle.

Normative decision analysis is rationalistic in its conceptualisation. This implies that a decision analyst who employs normative decision analysis can order the preferences pertaining to the optional outcomes, and, would make choice as to maximise (expected) value (Edwards, 1954). It is not hard to envisage why economists and mathematicians proffer prescriptive decision making. Except for charitable organisations, most businesses are established for the motive of making profit. In the face of competition therefore, organisations would strife to maximise their gains, and/or minimise their losses, thereby succumbing to rational approaches in decision analysis.

'Bounded rationality' casts a shadow on the viability of prescriptive decision analysis. It is understandable that future uncertainty cannot be fully known, nor accurately predicted. Thus, any decision analysis that pertains to the future is rationally bounded being subject to the accuracy of human foresight.

One school of thought is that departures from rational behaviour are frequently observed (Frank, 1987; Kahneman and Tversky, 1979), and, the normative techniques present computational difficulties such that they are often not employed in practice

(O'Shaughnessy, 1972). Instead, people tend to use 'heuristics' in making choices that would do, not necessarily optimal ones (Baron, 1994). Descriptive decision analysis is partly concerned with the usage of heuristics.

3.5 Descriptive techniques for decision analysis

Descriptive decision analysis has been proffered as an alternative to the normative approach. The models of this techniques include (Leigh, 1983):

1. Elimination by aspects;
2. Prospects theory;
3. Single criterion rule; and
4. Incrementalism.

The first rule is useful for decision making under conditions of certainty while the last two are suitable for decision making under conditions of risk or uncertainty.

3.5.1 Elimination by Aspects

This technique was originally proposed by Tversky (1972) and has been discussed by Slovic et al. (1977); and, Baron (1994). In this technique, the dimensions of a decision problem called aspects are identified. These aspects are synonymous with the goals of the decision maker. The magnitudes of the consequences of each option over the aspects are compared for the purpose of selecting the best. The evaluation and assessment of consequences could be done either quantitatively or qualitatively (Tversky, 1972).

In evaluating the alternative options, elimination by aspects (EBA) uses the dominance rule as the principle of choice. That is, for option A_1 to be chosen over A_2, it should be better than A_2 on at least one of the aspects and, should not be worse than A_2 on the other aspects (Svenson, 1979; Hogarth, 1980).

The advantage of EBA is that by equating aspects with goals, the needs and values of the decision maker are inadvertently accommodated. Further, the values of the decision maker are not rigorously evaluated, according EBA a simplicity that goes with heuristics.

In its simplicity however, EBA does not fully address the issue of conflicting goals. This shortcoming could be significant in construction where clients' needs (goals) have been shown to relate with each other. The success of EBA is thus underpinned on knowing the goals concerning a decision and in prioritising them.

Several variants of the EBA approach have been proposed. Some of these variants, as discussed by Svenson (1979), include:

1. the conjunctive criterion;
2. the disjunctive criterion;
3. lexicographic criterion;
4. minimum difference lexicographic criterion; and
5. semi-order difference lexicographic criterion.

3.5.1.1 The conjunctive criterion

This variant eliminates options over aspects but in addition, the decision maker specifies threshold values (of aspects) which a chosen option must attain or exceed (Svenson, 1979; Hogarth, 1980). The comparison usually starts from the least-liked to the most-liked attribute. As options are compared, those that fail to meet any threshold criterion are eliminated from further consideration. The elimination process continues until only one option is left, i.e. the ultimate best.

3.5.1.2 The disjunctive criterion

This is a mirror image of the conjunctive criterion (Svenson, 1979). Here the best option must have at least one attribute whose value is greater than the corresponding threshold, and, the respective values of all the other options should either be equal to or less than this threshold. A low score in one dimension could be accepted provided there is a compensatory higher score in another dimension (Hogarth, 1980).

3.5.1.3 Lexicographic criterion

Decision is based on selecting the option, which is better on the top ranked attribute. If there is a tie between two or more options at this level, the leading options are compared on the second best attribute (Hogarth, 1980). If need be, comparisons and deselections are continued in the direction of the third (fourth, fifth, etc.) ranked attributes until only one option is left as the ultimate best. Experiments by Slovic (1975) seem to support the idea that people make choices by lending preferences to dominant or most favourable aspects pertaining their decisions.

3.5.1.4 Minimum difference lexicographic criterion

This rule introduces a prerequisite as an addition to the lexicographic criterion. A minimum difference, which should distinguish the consequences of options, is introduced instead of their raw differential values. The options are compared, by proceeding in lexicographic order, from the top to the least ranked attribute. At each stage, the difference in magnitude between the respective options is used as means of elimination. Alternative options whose differences with the highest-scoring option do not exceed a specified minimum difference are carried forward to the next stage of comparison while weaker options whose differences are greater than the minimum difference are eliminated. The minimum difference used for the elimination is established by the decision maker, and it can vary for each attribute.

3.5.1.5 Semi-order difference lexicographic criterion

This is similar to the minimum difference rule except that this minimum difference is specified for only the top ranked attribute while the differences over the other attributes are all set at zero.

3.5.2 Prospects Theory

This theory was proposed by Kahneman and Tversky (1979), as an alternative to the subjective expected utility approach. It is a modified version of subjective expected utility intended to show how human choice deviates from the normative ideal (Baron, 1994). It considers decision making at two main phases: editing and evaluation. The editing phase transforms the offered prospects (i.e., the outcomes of options and their probabilities) in a way that would simplify their evaluation. The evaluation phase ranks the prospects in a bid to choose the one with highest value.

The values of prospects are weighed on two scales: π and ν. On the first scale, prospects theory weighs the probability of each outcome p by a non-probabilistic weight π, which is the amount p is assessed to impact on the overall prospect of an option. The second scale concerns the assessment of the values of outcomes which, are subjectively assessed as $\nu(x)$. Thus, for a regular prospect V, Baron (1994) shows that:

$V(x, p; y, q) = \pi(p)\ \nu(x) + \pi(q)\nu(y)$.

Basically prospects theory bears a great semblance with subjective expected utility with their difference being in the way different scales are used in them to assess the consequences of outcomes and risk factors of the associated states of nature. Like subjective expected utility, the comparative evaluation of the alternative decision options by prospects theory remains a forecast.

3.5.3 Single criterion rule

This is a simple heuristic rule. As its name infers, this rule proffers a single criterion of choice based on convenience. An example of the usage of this rule, given by Leigh (1983), is for a decision maker to accept the offer of a regular customer. Some construction clients use this rule in selecting a regular contractor for their intended projects. Being a rule of thumb, no strenuous effort is made to ensure that the very best option is selected.

The single criterion rule enables a decision maker to make a choice speedily. The rule however, suppresses the use of foresight in choice situations, making it more useful for decisions where the potential adverse effects are not grave.

3.5.4 Incrementalism

This strategy solves a problem in ways that could be considered to be crude. Instead of using goals in making decisions, the means available are simply employed. The vogue of this strategy is thus: 'the means justifies the end' (Leigh, 1983). For example, incrementalism would merely employ whatever option is available to save someone who is drowning. Incrementalism is thus useful where the decision maker is desperate. Its usage may have been imposed on the decision maker due to constraints that overshadow the search for other (better) alternatives.

The seeming advantage of incrementalism is that, at a minimum, the problem is solved instead of doing nothing. Its main disadvantage is that it negates the principles of decision making where choice should be made from a shortlist of alternatives. Since only one option is considered in incrementalism, there is obviously no guarantee that the best option would be selected. Selection of the best option via incrementalism can only occur by chance.

3.5.5 A retrospective view of descriptive decision analysis

In the descriptive approach to decision making, rationality is only weakly retained, i.e. the degree to which it is sought is relatively less than that of the normative approach. Thus, instead of strict optimisation, the descriptive models emphasise on satisficing (Coombs et al., 1970; Kotler, 1991) which, is a concept attributed to Simon (1961) aimed at countering full rationality (Leigh, 1983).

Satisficing is adopted because it is acknowledged that human cognition is limited as to fail short of identifying the very best courses of action or the accurate probabilities to be attached to outcomes. As a result, the quest of descriptive decision analysis is restricted to the search for those options that are viable and not necessarily maximal (Davis and Olson, 1984).

The absence of full information, or inability to analyse it, and, time and cost considerations combine to warrant satisficing by which less optimal solutions are accepted for some decision problems. For decisions with minimal consequences the adoption of a descriptive approach would be acceptable because the loss incurred in using any heuristic is minimal. However, decisions that have grave consequences should be analysed thoroughly (Baron, 1994; O'Shaughnessy, 1972). So choice of one strategy over the other would depend on the prevalent circumstances. Professional analysts should acquaint themselves with all techniques and use their discretion to apply the one that is most appropriate in each situation.

3.6 Normative and descriptive analysis

The two main differences between the two sets of techniques can be described as:

1. Normative decision making is highly rationalistic while descriptive decision making emphasises on satisficing; and,
2. Probabilities are not so much employed in descriptive decision making as with the normative approaches.

The normative approach implicitly captures the preferences of the client with respect to the desired goal(s). This is done, for example, as the utility of outcomes is measured. Therefore the goals of the decision maker are inherently accounted for in this approach. Although utility can measure preferences and account for risks, it is cumbersome and difficult to measure in practice (Flanagan and Norman, 1993).

Descriptive techniques on the other hand, account for the client's goals by casting the decision outcomes on dimensions, which are concordant with these goals. Descriptive decision analysis also allows the achievement of some goals to be traded-off especially when the multiple goals conflict with each other. Although descriptive decision analysis employs heuristics, it is sufficient for usage where, the opportunity cost has appropriately been considered.

The practical application of one of the analytical techniques, either normative and descriptive, is not an end in itself, as another phase of the analysis has to be considered before an option is eventually chosen towards resolving the problem at hand. This other phase is the sensitivity analysis.

3.6.1 Sensitivity Analysis

Sometimes two or more courses of action would have similar worth (Fellows and Langford, 1980). Choice in such situation becomes extremely difficult. Sensitivity analysis can resolve such conflict. Sensitivity analysis addresses the question, "what matters in this decision?" (Clemen, 1991). However, this important aspect is sometimes overlooked in some decision analysis considerations (Almeda and Bohoris, 1995; French, 1989).

In sensitivity analysis the variables (quantities attached to needs or estimates of probabilities) of the decision are slightly varied, and the analysis is re-evaluated in the light of these variations, to see the effect on the best outcome and to identify the crucial factors therein (Kaufman and Thomas, 1977). A *robust outcome* would remain best in the face of a sensitivity analysis (Golub, 1997).

Bayes rule can be used to judge the sensitivity of different decision options in the light of new information (Flanagan and Norman, 1993). By combining prior and posterior probabilities, the new probabilities pertaining to the different options can be ascertained and, decisions can be re-analysed in the light of the revised information.

Another approach to sensitivity analysis is to revise the goals of the decision maker. More goals could either be identified or the weighting of the initial set of goals could be revised. Either way, when the best outcome ceases to be best after a sensitivity analysis, the analyst(s) can recommend a few options to the decision maker, stating their respective strengths.

3.6.2 Implementing decisions

The decision analysis techniques are tools which help decision makers to act without replacing their discretion (Savage, 1954). Having analysed the alternative options and identified a robust course of action, the decision analyst then makes a recommendation which the decision maker is not obliged to accept (Golub, 1997). The act of deciding rests solely with the decision maker. Sometimes, the decision analyst and the decision maker could be the same person.

The main aim of decision analysis is to ensure that the option chosen matches the goals of the decision maker as best as possible (Lifson, 1972; MacCrimmon and Wehrung, 1977; Hogarth, 1980; Baron, 1994). The quality of a decision made, would in retrospect, be judged on how optimally it has satisfied human needs. The objective of satisfying human needs optimally through good decision making can thus be achieved by using the needs of decision makers as optimising functions in analyses pertaining their decision scenarios (Ohmae, 1988).

This research placed a searchlight on decision making, partly because, more construction clients will place a greater reliance on scientific approaches to decision making (Fellows and Langford, 1993). Inadvertently construction clients will expect their needs to be evaluated accurately as the criteria for making project decisions.

3.6.3 Setbacks of decision analysis

The following setbacks are noted with decision analysis:

1. No one approach works best for all circumstances (Bell et al., 1977).
2. There is no accurate formula for estimating the accuracy of decision outcomes pertaining to their associated probabilities and utilities (Lifson, 1972; Kaufman and Thomas, 1977).
3. The decision analysis techniques cannot eliminate the need for human judgement (Hogarth, 1980).
4. The decision analysis techniques are not flexible enough to capture the contextual considerations of certain problems (Hogarth, 1980).
5. Decision analysis could consume time (Kaufman and Thomas, 1977).
6. Decision analysis suffers non-acceptance in some organisations (Kaufman and Thomas, 1977).

All is not dismal with decision analysis as it has its benefits.

3.6.4 Benefits of decision analysis

Despite the foregoing setbacks, decision analysis has many benefits, which tend to override the potential disadvantages. Its advantages are:

1. Major decisions like the purchase of a new car, house, etc. often involve the synthesis of large amounts of information (Tversky, 1972). In such situations, decision analysis enhances the making of good choices by simplifying the task of

judgement involved relative to the human information processing capability (Baron, 1994; Fishburn, 1964; Hogarth, 1980).

2. Decision analysis helps decision makers in structuring their problems - to reduce their complexity (French, 1989).
3. Decision analysis enables one to review the quality of past decisions (Baron, 1994; Fishburn, 1964), thus allowing for accountability on the part of both analysts and decision makers.
4. Decision analysis provides a systematic and logical approach to decision making (Kaufman and Thomas, 1977).
5. Decision analysis enables risks and uncertainties in decision making to be confronted realistically rather than avoiding them (Kaufman and Thomas, 1977).
6. The outlay of decision analysis can reveal the amount of information to be gathered in any decision situation (Kaufman and Thomas, 1977).

These benefits suggest that the adoption of formal decision analysis would help in the making of choices that are accountable, and highlight areas of shortcomings. Thus the setbacks earlier stated should not deter the use of decision analysis. It would also be a welcome idea if researches on decision analysis are conducted to help reduce some of the weaknesses highlighted in sub-section 3.6.3.

3.6.5 Individual versus group decision making

The foregoing discussions have not differentiated between individuals and groups. The personalities of individuals differ from those of the groups or corporations to which they belong (McCuen, 1998). It is in this respect that anyone dealing with a corporation should seek to understand its disposition (Green, 1996). In terms of having needs and in making decisions, group dynamics come into play when more than one person is involved. Hull et al., (1977) have shown how the utility functions of individuals vary from those of the groups to which they belong.

Dickinson (1979) suggests that with groups, it is expedient for one person to be selected to represent them. Such a Project Manager, for instance, should speak with the voice of the group, and hence, can be treated with the ease of an individual.

The foregoing two paragraphs, point to a possible bias in the information generated in this research. In approaching corporate construction clients for information, responses were obtained from individuals. The respondents might have provided information with respect to their personal opinions and not that of their organisations. In this regard, chapter one had assumed that anyone responding to this research on behalf of a firm, was apt to speak for his/her corporation and would not pursue personal interests.

3.6.6 Advice for implementing decision analysis

The best decision is the one that achieves the goals of a client (Baron, 1994). Thus, the implementation of decision analysis should go beyond mathematical modelling, unto helping people achieve their needs (Johnson-Laird and Shafir, 1993). Better decisions can thus be guaranteed, only through the availability of relevant information concerning decision makers' goals. It therefore means that satisfactory project outcomes can be offered construction clients only through the accurate assessment of their needs.

3.6.7 Construction project decision making

Sequential decisions have to be made in construction production. Firstly, clients must decide on whether new building facilities are necessary. If they decide to build a facility, they will then have to establish the priorities to be attached to the project (British Property Federation, 1983). These priorities are then translated into the goals of the projects. Accurate identification, evaluation and usage of clients' priorities as decision making criteria, would improve the chances of achieving them optimally in the course of project delivery (Ozernoi and Gaft, 1977).

It is not an outcry that the act of buying or building a house warrants careful consideration because, long-time commitments are involved and, the needs of both owner(s) and user(s) are at stake (Lindley, 1971). This opinion applies to the procurement of projects to deliver all types of construction facilities. Thus means of identifying construction clients' requirements are valuable.

Although no problem is completely new (Golub, 1997), each decision situation may be unique (Fishburn, 1964). At a minimum, a different decision criterion should be established for each decision. It may be that some construction projects share similar characteristics, but the decisions pertaining to each project are circumspect. Thus, the decision analysis criteria for each construction project should be established afresh and not inferred from a previous project.

3.7 When to evaluate construction clients' needs as project decision making criteria

If an instrument for evaluating construction clients' needs is developed, or adopted, when should it be used? Marketing experts seek to identify consumers' needs first, before targeting their supplies. This principle is seen by some as an obligation (Smith, 1994). In the same vein this strategy can be adopted for construction production, that is, to assess clients' needs prior to physical construction.

Construction production can be phased in different ways. For example, Globerson (1997) considered the five phases of:

1. Project conceptualisation;
2. Preliminary design;
3. Detail design;
4. Production or execution; and,
5. Termination.

The first stage of conceptualisation (or inception) is where project characteristics are defined, and logically, should serve as the stage for identifying construction clients' needs (Burt, 1978). Preliminary design marks the beginning of the evolution of the project solution. If the client's needs have not been defined at the conception stage, then the design solution would not have anything to target. So it seems logical that clients' needs be defined prior to the design phase(s) of project schemes.

Although construction projects can stretch over long periods of time, most of the information needed to undertake their production can be generated at the inception phase, as it is the case with a tailor taking measurements for a dress prior to sewing. Hence the project information generated during briefing often concerns all aspects of the intended built facility, including: the administrative procedures needed; and, the identification of the characteristics of the personnel to bring about the end product.

3.8 Summary

Decision making was reviewed in its formal context. The act of decision making is a process and not an impromptu reaction. To make a decision, the decision maker must define the problem; search for its alternative solutions; shortlist the best few options; analyse the shortlisted options; and, decide on the basis of the analysis. There are theoretical approaches, which could be employed in the analytical phase of decision making. The analytical tools available are broadly two-fold: normative and descriptive.

The normative techniques are mostly quantitative and rationalistic. Their approach is to assess the magnitudes of the consequences of alternative decision options and the corresponding probabilities of occurrence of the states of nature that impact on them. The product of these two for each consequence is used in comparing the alternative options. The descriptive techniques on the other hand, are less rationalistic and emphasise on satisficing. They organise the decision outcomes on dimensions, which are concordant with the clients' goals. The options are then evaluated over these dimensions.

The chapter has shown that although several techniques for decision analysis abound, there is a common feature between them, which is the way they employ clients' needs as a basis of choice. Decision analysis warrants that, the right information especially on the decision maker's goals must be available before good choices can be made. This calls for the detailed evaluation of decision makers' needs with which decision options would be weighed and analysed.

If good decisions that go towards achieving construction clients' needs optimally are to be made in the course of construction project delivery then, construction clients' needs must be properly assessed. Thus, needs-assessment techniques play a significant supporting role in construction project decision making as they help generate yardsticks for good decision making. Since some construction clients sometimes fall short of identifying what they want, it would seem logical that (construction) professionals should help clients in identifying their needs. If decision analysts in construction production can commit the right resources towards identifying and evaluating clients' needs, then project decision making can proceed with more optimism. However, professional decision analysts in construction production should have the right tools to help them evaluate and understand their clients' requirements.

CHAPTER 4

RESEARCH METHODOLOGY

CHAPTER 4 : RESEARCH METHODOLOGY

4.1 Introduction

According to Leedy (1993) research methodology should address four main issues:

1. what data are needed;
2. where the data are located;
3. how the data are obtained; and,
4. how the data are analysed.

Following this guideline the data for this investigation and their sources are outlined. The principles by which they were acquired and analysed are equally explained.

The data for this research concerned two main sets of variables namely:

1. the project needs of construction clients; and,
2. factors which underpin the values attached to these needs.

Information on clients' construction needs resides in their minds. Although some factors influencing clients' needs may not come from their minds, information on these factors too, are most often than not held in the mind. Thus the data needed for the investigation came from the minds of previous construction clients.

It was the aspect of observing psychical data that introduced a psychological dimension in the conduct of this research. In this respect a psychological tool developed by Thurstone (1927), 'the method of paired-comparisons', was employed to measure clients' values. The research methodology in this chapter and the analysis in chapter 5 also drew a heavy inference from psychology.

4.2 Hallmarks of scientific research

This research followed as closely as possible the guidelines discussed by (Sekaran, 1992) as the eight hallmarks of a scientific research. These guidelines pertain to: purposiveness; rigor; testability; replicability; precision & confidence; objectivity; generalizability; and, parsimony.

Purposiveness

Purposiveness concerns a specific focus (Sekaran, 1992). The present research dwelled on 'construction clients' needs' where the main issue was: how to identify and evaluate more accurately, construction clients' needs as project decision making criteria.

Rigor

Rigor means that a research should be "theory-based" (Sekaran, 1992). Hughes (1994) in a similar manner suggested that a PhD research in construction management should establish a theory-based discipline for conducting the research, and, use construction as a source of data. While the data of the present research was obtained from construction clients, theories from psychology were used as a background. These included the considerations of:

- descriptive decision analysis (in chapter 2);
- analysis of clients' information for intransitive judgement (chapter 5); and,
- psychometric scaling of clients needs (chapter 7).

Rigor also concerns methodology and sampling (Sekaran, 1992). These two issues are elaborately covered in this chapter.

Testability

Testability means that the research should lend itself to logical testing, through hypotheses (Sekaran, 1992). Chapter 8 illustrates the testability of this research where, several hypotheses are tested.

Replicability

Replicability means that the research should be able to support the hypotheses in other similar circumstances (Sekaran, 1992). The research surveyed several types of clients in an attempt to sample diverse opinions and to ensure that the findings were replicable. Nevertheless, since the investigation had an exploratory motive, the factor of replicability was not over emphasised.

Precision & Confidence

Precision pertains to how close the findings approach reality, i.e. their validity. Statistical concepts were used to check the validity of the outcome of the investigation. The discussion in chapter 9 also highlights the level of precision of the findings.

Confidence refers to the probability with which an estimate is correct (Sekaran, 1992). A high confidence limit (95%) was used in the analyses, meaning that the findings will be correct 95% of the time and false only 5% of the time. Such a high level of confidence was used in the investigation to ensure greater reliability in the outcome.

Objectivity

By objectivity, the research findings should come from the data analysis and not personal opinion (Sekaran, 1992). Objectivity was employed in chapters 5, 6, 8 and 10 in defining the findings of the investigation.

Generalizability

For research findings to be generalizable they should be applicable to a wide range of people or organisations (Sekaran, 1992). Resource and time constraints had a limiting impact on the research such that the entire population of construction clients could not be studied. However, instead of studying few clients in case studies, data from several clients numbering 37, 38, 115, and 123 were at different times studied in the investigation, and, these clients came from different backgrounds. While the study of samples as opposed to populations might cast a doubt on the generalizability of findings, there is no proof however that, findings from such studies are not generalizable. This can only be ascertained by subsequent studies.

Parsimony

Parsimony suggests that the research should lend itself to simplicity and consideration of fewer factors (Sekaran, 1992). In this regard, the numerous meanings of needs compiled in the study were aggregated into eight main types of needs. This collation simplified the handling and analysis of data pertaining clients' requirements. In particular it reduced the tediousness with which their pair-comparisons information would have been collected and analysed. Similarly, the study of attributes influencing clients' needs was limited to 23, due to parsimony.

While the research design in this chapter tried to comply with the foregoing yardsticks the aspect of sampling had an uncontrollable effect on the eventual outcome as the investigator could not hand-pick the clients that participated in the research. The research could only be conducted with those clients who willingly agreed to participate in the investigation. The more the composition of the participants reflects the population of construction clients the more the findings would be generalizable. If however the composition of the participants is bias in any way, the outcome may be less generalizable. A researcher cannot easily control this aspect.

4.3 Hypotheses

The research dealt with three issues concerning construction clients, namely: 1) the quality of information supplied by them; 2) the preferences for needs portrayed by their information; and, 3) factors underpinning clients' differential preferences. It was these concerns that led to the generation and investigation of the following four main hypotheses:

1. Construction clients are not consistent in stating their needs;
2. The values of construction clients are the same;
3. The project requirements of construction clients are the same; and,
4. No predominant factors underpin construction clients' needs.

These main hypotheses provided a macro framework upon which the analyses were based. They are however different from the statistical null and alternative hypotheses (Leedy, 1993) which, are more specific and, are defined in chapter 8 along with the analyses to which they pertain.

4.4 Related works

Before the specific details of the research methodology are explained some precedent works linked with the present investigation are reviewed. From these works, insights were drawn and their principles were used as a guide in the design of the current investigation. The information to be supplied in respect of related works should at least include the following (Hughes, 1994):

1. what are these works?;
2. what are they about and how significant are they?; and,
3. how did they go about their work?

Using this checklist as a guide three works are highlighted in this regard.

4.4.1 Work on Communication

Based on a pilot study of professionals who had been members of a building team, and, whose opinions were surveyed by a questionnaire, Higgin and Jessop (1963) surmised that:

- good communication helps in the precise identification of clients' needs;
- one person is inadequate to identify all clients' needs and their implication for project delivery; and,
- first-timers or inexperienced clients require more assistance in the elicitation of their needs.

Obviously communication plays a significant role in construction production. Being that clients' needs reside in their minds, it takes good communication to portray these needs accurately. It was in this light that this research examined an aspect of communication where, the information supplied by some construction clients, were tested for reliability.

Kell (1989) suggested that problems exist with the communication between clients and designers. This suggestion can be stretched to infer that communication problems may exist between clients and other construction personnel. Higgin and Jessop (1963) distinguished two types of information, recorded and unrecorded. Subject to accuracy recorded information can be preserved and transmitted almost without distortion.

Hudson et al. (1991) developed a model to help preserve and transmit information generated by construction clients. On the other hand unrecorded information could be forgotten or distorted along the line of transmission. Even if all construction information were recorded or preserved, the fundamental issue would still be the accuracy of a given piece of information. Evidently if the information supplied by a client were wrong, then their preservation and subsequent usage would only lead to the specification and delivery of the wrong product.

The foregoing referenced works and others alike on communication, have not sought to evaluate or investigate the accuracy of information supplied by construction clients. While the preservation of client information is applauded, the present research went further into examining the reliability of information which construction clients (can) supply.

4.4.2 Work on the identification of clients' needs

Fellows and Langford (1993) surveyed some clients and contractors to establish what the clients wanted in their construction undertakings; and, how contractors perceived clients' needs. The clients they studied indicated, *inta alia,* that their major desire as the century closes is greater emphasis on value which, they (clients) defined to encompass the aspects of time, cost and quality. In contrast, contractors placed their emphasis on marketing their management-based services and not necessarily on client-values.

This finding by Fellows and Langford (1993) shows how the desires of clients could be undervalued by construction producers, a view that was echoed in chapter 2. A possible consequence of such misjudgement is the provision of wrong or inexact products, leading to client dissatisfaction. What may be needed is a strategy for identifying precisely what clients want.

Although Fellows and Langford (1993) were able to identify some goals of construction clients, they did not address the particular source(s) of these needs. For, Walker (1989) and British Property Federation (1983) have explained that, clients sometimes do not know clearly what they want. For instance, what underpins a client to desire quality of product more than aesthetics or, vice versa? If underpinning influences on clients' values exist, then their realisation would help in the identification of future clients' needs. Without any link between needs and factors underpinning them, the identification of clients' needs may be subject to inaccuracy.

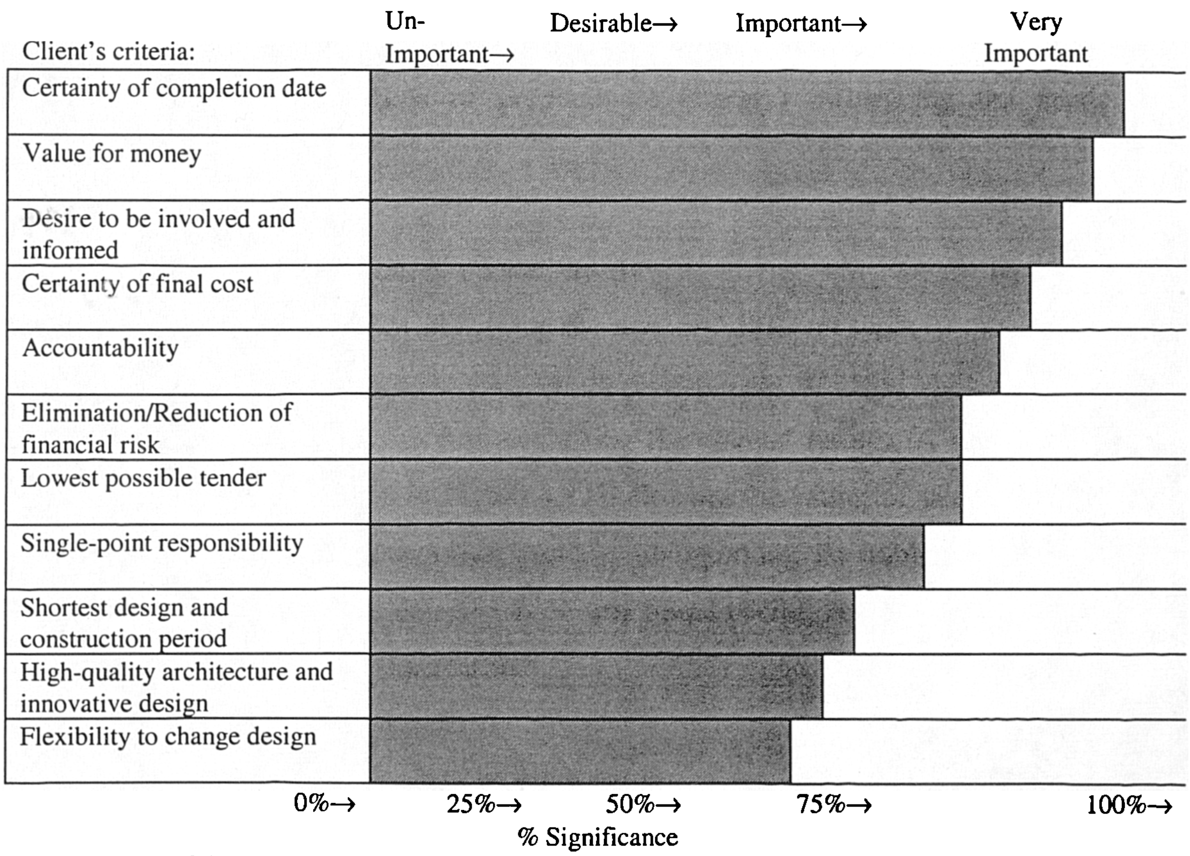
Thus this research investigated factors influencing clients' needs with the hope of determining the external factors, which control construction clients' project values. In this regard, the search for influences was directed at sources which included: culture (Graham, 1980); personality (Graham, 1980); and, taste (Golub, 1997). Other sources explored were: political; economical; legal; and project related factors. There is no research to date that has empirically linked one or more set(s) of construction clients' needs with one or more of these sources. This presents a knowledge gap filled by this research through the analysis of predominant factor(s) influencing the needs of construction clients.

4.4.3 Work on the evaluation of clients' needs

Masterman (1992) reported of measuring the needs of different types of clients in a bid to ascertain how they affected the decision on procurement strategy. Masterman did not elaborate on the method he used in evaluating the clients' ratings. A typical result of Masterman's work is shown in Figure 4.1. Following the rating of needs, Masterman classified them into four categories, namely: unimportant; desirable; important; and, very important. This type of categorisation was found useful, and, was employed in the analytical considerations of this research.

Masterman's work is significant in pointing out that clients' priorities in terms of project requirements would influence their satisfaction with the project outcome. This agrees with Moleski's (1978) suggestion that project satisfaction is mainly tied to the needs that are most highly desired. Figure 4.1 shows that all needs measured by Masterman were desired highly. However this may not be so when all the numerous clients' needs are considered.

Masterman evaluated the clients' needs at an ordinal level of measurement. However, MacCrimmon and Wehrung (1977) had recommended that clients' needs, as decision making criteria, be measured on an interval or ratio scale. For this has the advantage of showing relatively, how much one need is preferred over the other(s), and, provides a better framework upon which better decisions can be made in the course of project delivery (Hershberger, 1985). This research followed expert advice by measuring the needs of construction clients at an interval level. It was in this regard that the method of paired-comparison was adopted for measuring clients' needs in this research. The method of paired comparisons yields interval data, which are more versatile than nominal or ordinal data.



(NB: Not to scale)

Fig. 4.1 : Average rating, by clients, of criteria for project success
(Source: Masterman, 1992).

4.5 Choice of quantitative survey as research strategy

There are different research strategies, and, choice of one for an investigation depends partly on the research question. Yin (1994) gives a categorisation of strategies and accompanying research questions that (can) go along with them (see Table 4.1). A combination of strategies can be used in a given study, for example: 'a survey within a case study', 'a case study within a survey', etc.

Table 4.1 : Matching of research strategies with types of questions

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?
Experiment	How, Why	Yes	Yes
Survey	Who, **What**, Where, How many, How much	No	Yes
Archival analysis	Who, **What**, Where, How many, How much	No	Yes/No
History	How, Why	No	No
Case study	How, Why	No	Yes

Source: (Yin, 1994).

This research partly concerned how (much) needs were desired by construction clients. From Table 4.1, any of the strategies could have been used if the research had considered this question alone. However, in addition to the 'how much' question, the research also concerned **what** factors underpin clients' needs? This second attribute of the research question limited the choice of strategy to surveys and archival analyses. Not being sure if information on older projects could be found or would be accurate, the research was conducted with on-going and recently completed projects. This thus avoided an archival analysis in preference for a survey. The related works of Section 4.4

were conducted by means of surveys. Drawing an inference from these works, a survey methodology was chosen for this research.

4.5.1 Choice of the analytical survey method

Surveys could either be descriptive or quantitative (Leedy, 1993). By highlighting the information used in this research, Section 4.3 provided a basis for identifying the most appropriate type of survey for the research. Being that the clients' values were quantified unto an interval scale; and, the factors underpinning clients' desires were measured using descriptive statistics, a quantitative approach as opposed to a qualitative one was selected for the investigation. Thus the 'analytical survey method' was chosen. This is a methodology whose data are primarily quantitative and statistics is the main tool for analysing them (Leedy, 1993).

A survey in this respect does not merely gather facts by observing a subset or subsets of a population but studies relationships between variables (Kerlinger, 1964). In this regard the relationship(s) between the needs' preferences of the clients were studied for distinctive patterns, and major factors, which bear on these relationships, were identified.

4.5.2 Research design

Research design refers to the plan by which either: individuals, groups, objects, or variables, are compared and analysed (Sanoff, 1977). Some classifications of research are used in describing the design chosen for this research. These classifications which shed differing light on the overall design (Blaxter et al., 1996) are not completely exclusive, but tend to fall on a continuum (Blalock and Blalock, 1982).

The main design feature that describes this research is that it was a 'cross sectional study', as it pertained to a given period of time (Campbell and Stanley, 1963; Bailey, 1987; Bouma and Atkinson, 1995). The cross-sectional nature of the research is based on the understanding that the clients studied were contemporaries, and, information was supplied in respect of projects delivered within a specified time frame, the nineties.

Cross-sectional studies focus on studying and describing the characteristics of a group or the differences between two or more groups (Zechmeister and Shaughnessy, 1992; Sommer and Sommer, 1991) hence, some literature (like Bouma and Atkinson, 1995) refer to them as 'comparative studies'. A comparative survey of two or more groups of clients reveals their similarities and differences (Berkowitz, 1996a). A cross-sectional study was chosen because, the act of observing the needs of clients over different time scales was impossible for a PhD research which, is limited by a specified time-scale.

In the light of the foregoing explanation, the present research can be described as a cross-sectional survey where predominant factors influencing construction clients' needs-preferences were observed. The research was not conducted in an open-ended time frame. Thus, the preferences of construction clients and factors influencing them could not be verified subsequently on live projects. Without a series of verifications, it would be premature to conclude definitively that certain factors are causing certain preferences. Therefore the research did not infer causal relationships in its observations. Since association between factors and needs was studied without emphasising on causality, the research can be described as exploratory in nature as opposed to explanatory or descriptive (Yin, 1994; Phillips and Pugh, 1994).

Exploratory studies are done to help understand problems and phenomena which are unknown and for advancing knowledge (Sekaran, 1992). Exploratory studies also provide a springboard for developing theories and hypothesis towards future research. The factors established in the exploration of this research could later be tested as hypotheses in future investigations.

4.5.3 Discounted methodologies

Research survey is a wide domain, consisting of many methodologies. One method has to be used in an investigation. In order to arrive at a solution as to which research design to use in this investigation, some of the other methodologies were discounted. Accordingly, an experimental methodology was discounted because, the clients who would have accepted to participate in the research were widely dispersed such that it was impracticable to co-ordinate them in an experiment. Also an experimental methodology would have warranted the participation of willing clients who were all at the point of procuring their projects. This approach would have limited the possible number of clients willing and/or able to participate in the research with the risk of rendering the research effort futile. There is also the aspect of 'control' in experimentation, which did not fit-in with the current research. Thus an experiment was impracticable on this occasion.

An 'ex-post facto' (retrospective) methodology could have been used, but was not, because it has several shortcomings which include:

- It is difficult to control the independent variables and/or events that have occurred (Cook and Campbell, 1979; Kerlinger, 1964; and Mouly, 1978).
- It is difficult to randomise subjects/objects of study (Cook and Campbell, 1979; Kerlinger, 1964; and Mouly, 1978).
- There is the risk of improper interpretation of findings (Cook and Campbell, 1979; Kerlinger, 1964; and Mouly, 1978).
- In view of the limited number of causal factors which may have been considered in an ex-post facto study, the research may not yield pinned-down answers at the end of the day as some other factors might have influenced the observed events (Chapin, 1955).
- There is the possibility of reverse causality between the dependent and independent variables (Robson, 1993).

It is generally difficult to ignore or avoid these weaknesses (Black, 1993), hence, the approach was not used in this research. However, its main principle of looking back was adopted, where clients' needs were evaluated and studied prior to identifying the factors, which influenced them. Since the ex-post facto methodology was not in use, the causal relationship between needs and influencing factors was downplayed.

The case study approach, which is another viable tool, was not selected because the major factors influencing clients' needs have not been substantiated in an earlier research. So the present research sought to establish them with data from many clients.

Also, case studies require data from more versatile clients, who can foresee many possibilities. One objective of this investigation, as stated in chapter 1, was to study the diversity of construction clients' preferences. If few clients were surveyed via case studies, it is more likely that their expressed perception of construction clients' preferences may not reflect that of the entire population. To overcome this difficulty, the research has to obtain data from clients who are very knowledgeable, well experienced and broad-minded. If clients who meet these qualifications were not willing to participate in the research, then the prospects of the outcome would have been diminished.

On face value, there is no guarantee that a survey would yield a better outcome than a case study. However, since the former involves the views of many people, much more than the later, the probability that a wider range of opinions will be elicited in a survey is higher than that of a case study. It was on this basis that a case study was discounted in the present research.

4.6 Information used in the research

Primary data was obtained from construction clients for the investigation. Two main aspects of information were solicited from the clients and these concerned their construction project needs and factors influencing those needs. On needs, the clients were asked to identify the meanings they attached to eight generic requirements (see section 2.3.1), and, to prioritise those requirements. Psychometric scaling was used in measuring the amount of desire attached to needs by the clients. This had the effect of representing these desires on an interval scale.

Potential attributes, which may be associated with the desire of needs, were identified from literature. The degrees, to which these attributes impact on clients in their desire of needs were rated by the clients, through a likert type of scale. The views expressed by the clients concerning the attributes were scaled by descriptive statistics. Combining different methods of measurement this way is acceptable for data collection (Frankfort-Nachmias and Nachmias, 1996; Berkowitz, 1996b).

4.6.1 Use of questionnaires for data collection

Being that desires are not physical objects that can be touched by hand, it was improper to use physical surveys in ascertaining construction clients' desires. The research could only rely on clients to express their values and perceptions. It was in this light that the use of questionnaires was chosen as the channel for data collection. Two different questionnaires were employed in acquiring the information needed for the research. They targeted the two main aspects of information addressed by the investigation, namely: clients' needs, and, factors influencing them. The first questionnaire sought for information in respect of clients' needs' and the preferences attached to them whilst the second evaluated the importance which some attributes had on clients' preferences.

Although interviews can elicit better data than questionnaires, (Mobley and Locke, 1970), the many responses needed to afford a valid psychometric scaling of clients' desires inhibited the use of this approach because the time, cost and logistics of arranging and interviewing hundreds of clients in diverse UK locations were, in Sekaran's (1992) word "enormous". Thus, interviews were not employed in the conduct of this research.

The mailed questionnaire is useful as a tool where the collection of factual information is concerned (Berkowitz, 1996a). The scaling procedure adopted in this research demanded that clients mostly tick their needs-preferences. Given a checklist of needs, it should be relatively straightforward for clients to distinguish those they preferred. They should also be able to state how much some listed attributes impacted on their desires. Thus the use of questionnaires stood out favourably as means of data collection.

Questionnaires have the added advantage of masking the potential negative influences of the interviewer. For instance, Bailey (1987) explains that the interviewees may not like the interviewer for reasons like dressing, speech, manners, etc. The interviewer may also bias the respondents' answers by asking leading questions. The mail questionnaire can overcome all these potential setbacks.

Questionnaires however have the disadvantage of generating low response rates from would-be participants (Sekaran, 1992). To circumvent for this shortcoming, a large number of questionnaires were sent out in order to generate a large number of responses that would be sufficient for the intended scaling of clients' values.

4.7 The first questionnaire

The first questionnaire was designed based on the eight generic construction needs in Table 2.2. It was prepared in three sections: A, B, and C. Section A which was knowledge-based requested general background information concerning the responding clients. Issues raised in this section included type of business, capital strength, type and numbers of projects undertaken, etc.

Section B of the questionnaire, which was person - (or corporation) - based presented the eight main types of needs as defined by the researcher together with their meanings. Clients were asked to verify the meanings that were applicable to them under each main need and state additional meanings not given by the researcher. They were also asked to suggest other main types of needs not reflected in the questionnaire. The clients were instructed to base their definitions of needs on a single particular project that they had specified in Section A of the questionnaire.

Section C (also person - based) was prepared in form of 'force-choice' questions (Guildford, 1959). The eight main types of needs were paired with each other and the clients were requested to indicate their relative preferences for one need in each pair. The essence of the paired-comparisons was: 1) to enable the clients' level of consistency in making choice-judgements to be studied; and, 2) to enhance the scaling of the clients' values through the psychometric method of paired comparisons. Being that eight needs were paired with each other in this Section, there were altogether $\binom{8}{2} = 28$ pairs of needs. Appendix A shows the final version of the first questionnaire, as it was used in the investigation.

To minimise the effects of response bias on the part of clients, the check and balance procedure of 'acquiescence' (David, 1969; Rust and Golombok, 1989) was used in arranging the paired needs. Ross (1934) introduced the concept of acquiescence as a procedure for minimising response bias in paired-comparison measurements. The concept involves the special ordering of paired stimuli so as to account for 'space' and 'time' errors.

Through acquiescence, a stimulus is arranged to appear (almost) equally on both the left and right hand side. Also, a stimulus is staggered in its sequence of appearance. For example, the stimulus '*Economy*' is shown in Section-C of Appendix A, appearing on the left side of the first stimulus-pair. It next appeared on the right hand side of the fourth pair. By staggering stimuli this way, clients were not deliberately influenced by a biased follow-on effect to indicate a continued preference for a particular need merely on the basis of preceding choices.

Ross (1934) developed a Table of sequential combinations, which can be used to pair stimuli. Each sequential combination depends on the total number of stimuli to be paired. Ross' Table was used in pairing the eight generic needs in Section C of the questionnaire in Appendix A.

4.7.1 Piloting the first questionnaire

The designed questionnaire was piloted with three clients who were based in the West Midlands, and, with whom SEBE had some form of contact. The trio consisted of a major property developer (corporation), an individual who owns some housing units and the estate department of an academic institution. The developed questionnaire was sent to them where they were asked to complete it as research participants. A space was provided for them to criticise or comment, as they deemed fit.

No major suggestions were proffered by these three clients, however, they identified a few additional meaning(s) of needs. The response of one of these clients, (the property developer), is shown in Appendix B. Since the clients were not critical in their response, and had completed all sections of the questionnaire, the information they supplied were used along with those of other clients who later completed and returned their questionnaires.

Armed with a ready questionnaire the investigation was in a position to approach a larger number of clients for data in respect of construction needs. Some clients were accordingly sampled and requested to fill the questionnaire.

4.7.2 Sampling of construction clients to participate in the research

For obvious logistical reasons, not all construction clients could be involved in the study, as they number thousands. Some clients from the population were thus requested to participate in the research investigation. Those clients who were invited to participate in the research were chosen by "convenience sampling" (Leedy, 1993). In this type of sampling, clients are approached haphazardly as they are encountered. There is no deliberate attempt to sample a particular client. This type of sampling is based on hope that the right type and/or combination of clients would be approached, and that those who agree to participate in the research would provide the appropriate mixture of respondents needed.

In convenience sampling a true representation of the population is not inferred (Frankfort-Nachmias and Nachmias, 1996), as subjects are randomly approached. By this potential limitation, the findings of the research may not necessarily be generalizable unto the entire population (Kane, 1985). Despite this shortcoming convenience sampling was used because it offered the opportunity to obtain a relatively greater number of clients that would participate in the study. For, if only a certain type of clients had been sampled, or the sampling had been limited to a certain region, the potential number of clients who can participate in the research would have been reduced greatly.

To access clients via convenience sampling, the following documents were used as sources of information:

- Housing Associations and Directory Yearbook (NFHA,1996);
- Municipality Year Book and Public Services Directory (Yorke, 1996); and,

- UK Directory of Property Developers, Investors and Financiers (Building Economics Bureau, 1996).

Addresses of clients from these documents were extracted at random. The selected clients were approached with the questionnaire (shown in Appendix A), with the hope that they would be willing to participate.

4.7.3 Administration of the first Questionnaire

Having selected some construction clients for the investigation from the aforementioned sources, the questionnaire in Appendix A was sent to them. They were each requested to fill and return the completed questionnaire to the researcher. Each questionnaire was accompanied by a covering letter, which explained the essence of the research. A sample of the covering letter used is attached to the questionnaire in Appendix A.

Cost and logistical considerations limited the number of clients who were requested to take part in the investigation. In all, 600 questionnaires were sent out by first class surface mail to various clients. This was done within the month of February 1997. Seven of the despatched questionnaires (1.17%) were returned undelivered, as the corporate clients to which these were addressed could not be traced. The returned questionnaires were not forwarded to the clients' correct addresses, as these were unknown. This left a net total of 593 despatched questionnaires. The net breakdown of questionnaires sent to three main types of clients is shown in Table 4.2.

Table 4.2 : Breakdown of clients approached for information

	Proportion approached:	
Type of client	Number	Percentage
Public clients	100	16.86
Private individuals	100	16.86
Private corporate clients	393	66.27
Total:	593	≅100.00

Telephone follow-ups were made with some of the clients who had been approached with the questionnaire. This set of clients included those who had some form of link with SEBE and, a few others whom the researcher had sought to establish a contact with. The follow-up yielded fruit as most of those contacted this way responded positively. Midway into April 1997, however, an attempt to generate even more responses was made. This involved sending reminders to those clients who had not returned their completed questionnaires. The reminders were made up of a copy of the questionnaire together with the initial covering letter.

4.7.4 Respondents to the first questionnaire survey

Completed questionnaires were returned between February and May, 1997. 130 clients returned their (completed) questionnaires to the researcher. By adding the 3 responses obtained in the pilot study a total of 133 responses were obtained. These 133 responses are equivalent to 22.32% of the 596 (593 + 3) approached for participation. The breakdown of respondents in comparison with those approached is shown in Table 4.3.

Table 4.3: Breakdown of clients who responded

Type of client	Number of participants:		(%) Percentage of:	
	Approached	Responded	Those Approached	All Respondents
Private individuals	101	5	4.95	0.84
Public corporate clients	101	27	26.73	4.53
Private corporate clients	394	101	25.38	16.78
Total:	596	133	-	22.32

Sekaran (1992) had hinted that questionnaires tend to elicit low response rates. Although the overall percentage of respondents in this survey (22.32%) was low, their numerical strength was sufficient to allow for conclusions to be derived from the analysis of their information.

4.7.5 Screening of information supplied by clients through the first questionnaire

The collected data were screened to ensure their "acceptability" (Berkowitz, 1996a). The screening checked to see whether respondents had properly filled the questionnaire. Two clients were found, who did not complete Section-C of the questionnaire and, a further eight completed it partially. These eight clients had (mistakenly or deliberately) skipped one page while filling the questionnaire. For these clients it was ideally possible to verify if the partial completion of the questionnaire was deliberate or a mistake. However due to pressure of time the verification was not made and their responses were ignored in the analyses. This action reduced the number of questionnaires completed validly to a tentative sum of 123.

4.7.6 Characteristics of the clients who responded

Background information is provided in respect of the aforementioned 123 clients. Some of these clients withheld some information, so the total number of clients in respect of some of the following characteristics does not add up to 123.

Five clients (4.07%) were individuals while 118 (95.93%) were corporations. 52 of the clients (42.28 %) described themselves as property developers; 67 (54.47 %) did not, while 4 (3.25 %) were silent on this issue.

Four clients (3.25 %) did not indicate whether their projects were completed or on-going. 31 clients (25.20 %) reported on projects that were still under construction while the remaining 88 clients (71.54 %) reported on projects that had been completed. Of this 88, 45 (51.14 %) had their projects completed in 1996; 30 (34.09 %) had theirs completed in 1995; 4 (4.55 %) reported on projects completed in 1994; and, three sets of clients each numbering 3 (3.41 %) reported on projects completed in: 1991; 1992; and, 1993. Thus information was supplied in respect of projects where the delivery date was skewed towards the late nineties.

Twenty two clients (18.03% of 122), used the property upon which they reported while the other 100 (81.97%) leased-out the property. 81 projects (66.94% of 121) pertained to new developments while 40 projects (33.06%) concerned refurbishment works. Of these refurbishment projects, 22 of them (55.00%) also encompassed alterations and/or extension works.

The size (gross floor area) of facilities ranged from $50m^2$ for renovation works to $16{,}500m^2$ for new developments, with the average size being approximately $1{,}250m^2$. These values are based on information supplied by 92 clients. Although the number of storeys of the building facilities ranged from 1 to 16, most of them (93 = 80.87 %) consisted of three floors or less.

The projects on which information were supplied, are located in diverse UK locations, with most of them being in England, a few in Scotland and Wales and one from the Isle of Wight. 49 clients (39.84 %) chose not to identify the locations of their projects. Of the 74 locations that were identified, the responses showed that London with a frequency score of 12 was the only loaded location. The other 62 projects were located in places like Birmingham, Wolverhampton, Manchester, Staffordshire, Glasgow, Edinburgh, Liverpool, Reading, Kettering, Leicestershire, Gloucestershire, etc. The other client/project characteristics are for ease of reporting, compiled in the following tables.

Table 4.4 : Distribution of the work-force of the corporate clients

	Number of employees			
Size	1-50	51-500	Over 500	Total
Respondents	51	50	17	118
Percentage	43.22	42.37	14.41	100

Table 4.5 : The turnover of the clients is distributed as:

Turnover (£ - Sterling)	Less than 50,000	50,000 to 100,000	100,000 to 1M	Over 1M	Total
Respondents	4	5	18	89	116
Percentage	3.45	4.31	15.52	76.72	100

Table 4.6 : The number of projects executed by the clients within the last five years (i.e., 1992 to 1996) were distributed as:

Range of projects	1	2 - 5	6 - 20	Over 20	Total
Respondents	5	18	30	69	122
Percentage	4.10	14.75	24.59	56.56	100

Table 4.7 : The average price of projects reported upon by the clients:

Project price (£ - Sterling)	Less than 50,000	50,000 to 100,000	100,000 to 1M	Over 1M	Total
Respondents	11	7	47	55	120
Percentage	9.17	5.83	39.17	45.83	100

Table 4.8 : The types of facilities reported upon consisted of:

Type of facility	Number	Percentage
Office	14	11.57
Banking/Financial	4	3.31
Residential	74	61.16
Academic	4	3.31
Commercial	17	14.05
Industrial	4	3.31
Others	4*	3.31
Total	121	100.02

**NB: Others refer to miscellaneous facilities like swimming pools and/or leisure centres.*

Clients were asked to report on individual projects - a step to reduce the effect of changing needs as each project is developed. All respondents specified a single project as the basis of their information. Responses were sought from highly placed management staff, where corporations were concerned. This proactive effort was made in an attempt to ensure that those who replied had the relevant information and more so, the authority to speak for the organisation which they represented. Responses were provided by personnel who included: (Assistant) Chief Architects; (Assistant) Chief Quantity Surveyors; Managing Directors; Development Managers; Secretaries; Technical Services Managers/Directors; etc.

The information collated in this sections, were obtained from the responses revealed by the clients in sections A of the first questionnaire. The other data they revealed through sections B and C of the questionnaire are collated in chapter 8 and Appendix C respectively.

4.7.7 Preview of how the generated information was analysed

Having obtained information through the first questionnaire, the first task undertaken was to analyse the information supplied by the sampled clients for reliability. The test for reliability was done, by checking the consistency with which the clients made their preference choices. Information supplied in Section-C of the first questionnaire was used in this aspect of the analysis which, is fully reported in chapter 5. On the basis of this analysis some clients whose information were adjudged to be highly intransitive were dropped from further consideration in the course of the research.

Of those clients whose data were upheld as being (relatively) reliable, some were selected for a further in-depth study. In this regard chapter 6 analysed the express preferences of the clients for similarity where they were stratified into needs-based sub-groups. Cluster analysis was used as the statistical tool. The analysis of chapter 6 employed the information collated in Appendix C, and, addressed the second main hypothesis specified in Section 4.3. After classifying the clients into homogenous sub-groups, two groups of clients were sampled for further study where their respective needs were compared along with the factors, which influenced them. The analysis leading to the classification of construction clients is reported in detail in chapter 6, and the evaluations of the values of the clients are reported in chapters 7 and 8.

4.8 Multi-stage sampling of construction clients

Obtaining a good sample for a study is a key factor in research (Berkowitz, 1996a). Sampling was employed in this research. Having classified the clients into four needs-based groups, the research was in a position to study some or all of these groups. It was in this context that multi-stage sampling was employed in selecting some of the groups of clients that emerged. This type of sampling involves using different sampling techniques in successive phases (Leedy, 1993).

The hierarchical path followed in the 'multi-stage' sampling of this investigation was: 'non probability - convenience - cluster sampling'. Each of these adjectives represents a type of sampling. Figure 4.2 illustrates the sequential combination of the multiple sampling techniques.

Non-probability and convenience sampling were discussed in section 4.7.2 while identifying those approached for participation in the research. The next phase of the sampling, according to Figure 4.2 concerned stratified-sampling. In this regard, the cluster analysis of chapter 6 was interpreted as a stratification of the clients into four different needs-based groups. Having stratified the clients via cluster analysis, some or all sub-groups (strata) could be chosen as "study-groups" (Black, 1993) for the investigation.

4.8.1 Purposive cluster sampling

From the aforementioned four, two groups of clients were sampled, namely: G1 and G2. In choosing them 'purposive sampling' was used. In purposive sampling a researcher can subjectively select some or all groups, and, is equally allowed to sample some or all members of a chosen group (Frankfort-Nachmias and Nachmias, 1996). G1 and G2 were accordingly chosen due to both their relative higher levels of homogeneity and numerical sizes (see Tables 6.1 and 6.3). Their homogeneity ensured that more similar opinions were considered and their higher sample sizes enabled their preferences to be scaled by the method of paired comparisons.

Being that the two groups of clients were compared with each other in the analyses, it was better to compare two groups of individuals or corporations than to compare one set of corporation/individuals and a combination of corporations and individuals. Responses obtained from the administration of the first questionnaire showed a greater participation of corporations (96.24%) in contrast with individuals. In view of this large skew, the second questionnaire was deliberately developed for corporations. This decision meant that private clients were screened out in the second phase of data collection.

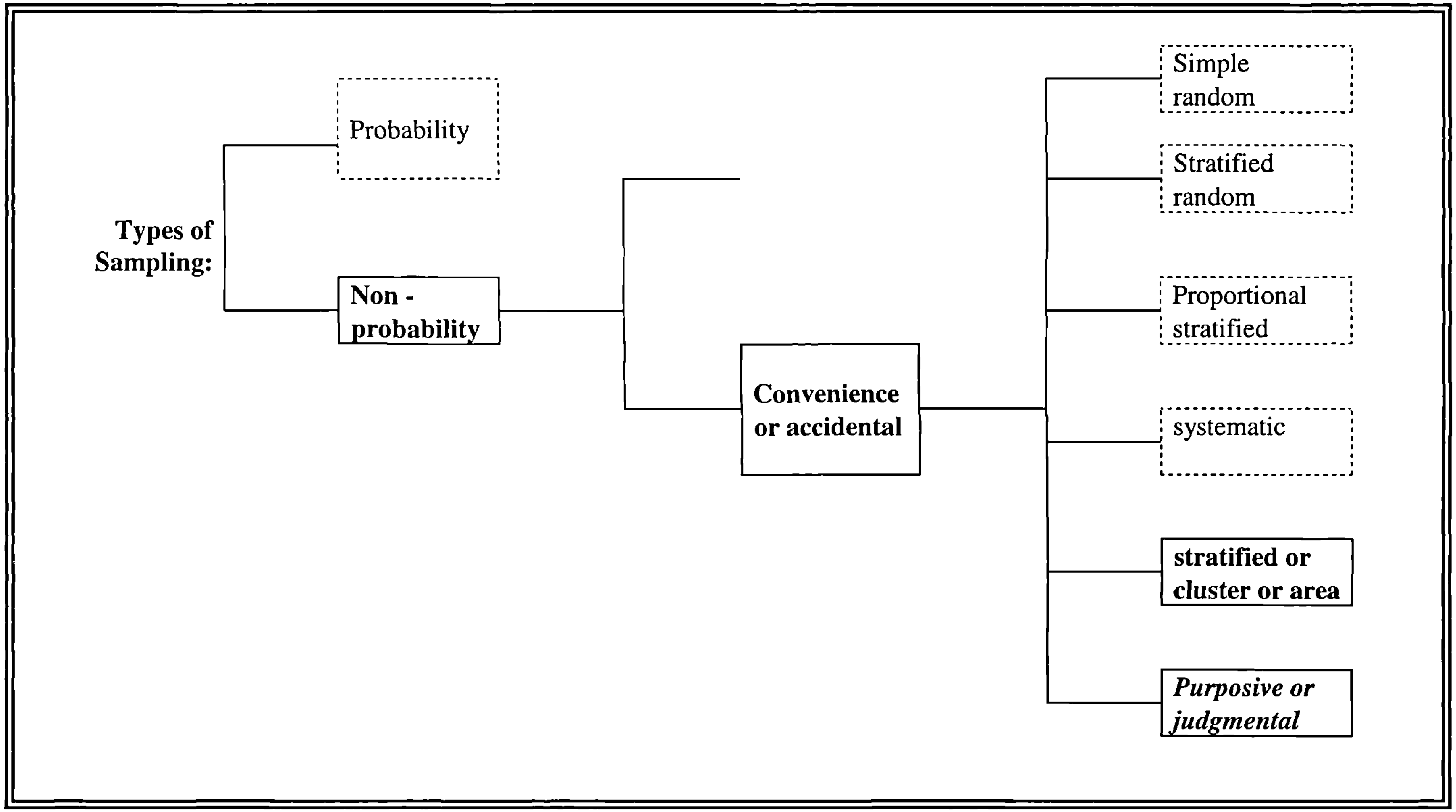


Figure 4.2 Hierarchy of sampling techniques *(Source: Leedy, 1993)*

By comparing the backgrounds of members in the selected two groups all G2-clients were corporate clients while all the five private clients mentioned in section 4.7.7 belonged to G1. A sixth G1-client did not answer many questions concerning his/her background and could not be categorised as private or corporate. These six clients in reference were purposively dropped from G1 to enhance a comparison of two typical corporations, namely: G2 and revised G1. The dropping of these six clients from G1 reduced its size to 38 members. This new size is virtually equal to that of G2 where there are 37 members. The final composition of clients selected for the investigation is shown in Table 4.9. The purposive sampling of members in G1 and G2 concludes the multi-stage sampling adopted in the study.

Table 4.9 : Final composition of clients in the sampled two groups

Composition of clients	
Group 1	Group 2
C4, C8, C9, C10, C14, C15, C16, C18, C25, C26, C27, C28, C29, C30, C32, C35, C36, C37, C40, C41, C44, C55, C57, C59, C62, C63, C65, C67, C75, C78, C81, C84, C99, C107, C109, C118, C119, C123 (38 in number)	C5, C6, C7, C12, C24, C31, C38, C39, C47, C49, C51, C58, C60, C61, C66, C69, C71, C74, C79, C86, C87, C90, C92, C97, C102, C103, C104, C106, C108, C110, C113, C115, C125, C126, C128, C129, C132 (37 in number)

NB: C*i* is the name tag assigned to the *i*th client who returned the questionnaire

4.8.2 Characteristics of G1 and G2

The background characteristics of G1 and G2 are compiled in Table 4.10 and depicted in Figure 4.3. The distribution of the frequency of occurrence of attributes for G1 and G2 in Figure 4.3 shows that each time an attribute occurred often with G1 the same thing happened with G2. There is a high similarity between the two frequency distributions.

Table 4.10 : Compilation of client data

Main Feature	Attributes	G1 (38 in number = n_1) Frequency (x_1)	G1 Relative Frequency (%)	G2 (37 in number = n_2) Frequency (x_2)	G2 Relative Frequency (%)
Level of income	INCOME - 1	0	0.00	1	2.86
	INCOME - 2	0	0.00	1	2.86
	INCOME - 3	6	16.67	6	17.14
	INCOME - 4	30	83.33	27	77.14
	Total (n_i)	*36*	*100.00*	35	*100.00*
Level of experience (with construction undertakings)	Experience-1	0	0.00	1	2.78
	Experience-2	4	10.53	6	16.67
	Experience-3	8	21.05	9	25.00
	Experience-4	26	68.42	20	55.56
	Total (n_i)	38	*100.00*	36	*100.01*
User function of facility	Office	5	13.16	3	8.33
	Financial.	1	2.63	1	2.78
	Residential.	19	50.00	20	55.56
	Acad.	2	5.26	1	2.78
	Commercial.	3	7.89	7	19.44
	Industrial.	2	5.26	1	2.78
	Distinct	6	15.79	3	8.33
	Total (n_i)	38	*99.99*	36	*100.00*
User of product	Self	11	28.95	3	8.33
	Others	27	71.05	33	91.67
	Total (n_i)	38	*100.00*	36	*100.00*
Type of construction	Newdevelopment	24	63.15	29	80.56
	Refurbishment.	14	36.84	7	19.44
	Total (n_i)	38	*99.99*	36	*100.01*
Size of organisation (Number of employees):	W/Force-1	13	34.21	18	48.65
	W/Force-2	17	44.74	15	40.54
	W/Force-3	8	21.05	4	10.81
	Total (n_i)	38	*100.00*	37	*100.00*
Background of client (Whether a property developer?)	Developer.	13	34.21	21	60.00
	Not a developed.	25	65.79	14	40.00
	Total (n_i)	38	*100.00*	35	*100.00*
Price of development	Price-1	1	2.63	2	5.55
	Price-2	2	5.26	1	2.78
	Price-3	16	42.11	16	44.44
	Price-4	19	50.00	17	47.22
	Total (n_i)	*38*	*100.00*	*36*	99.99

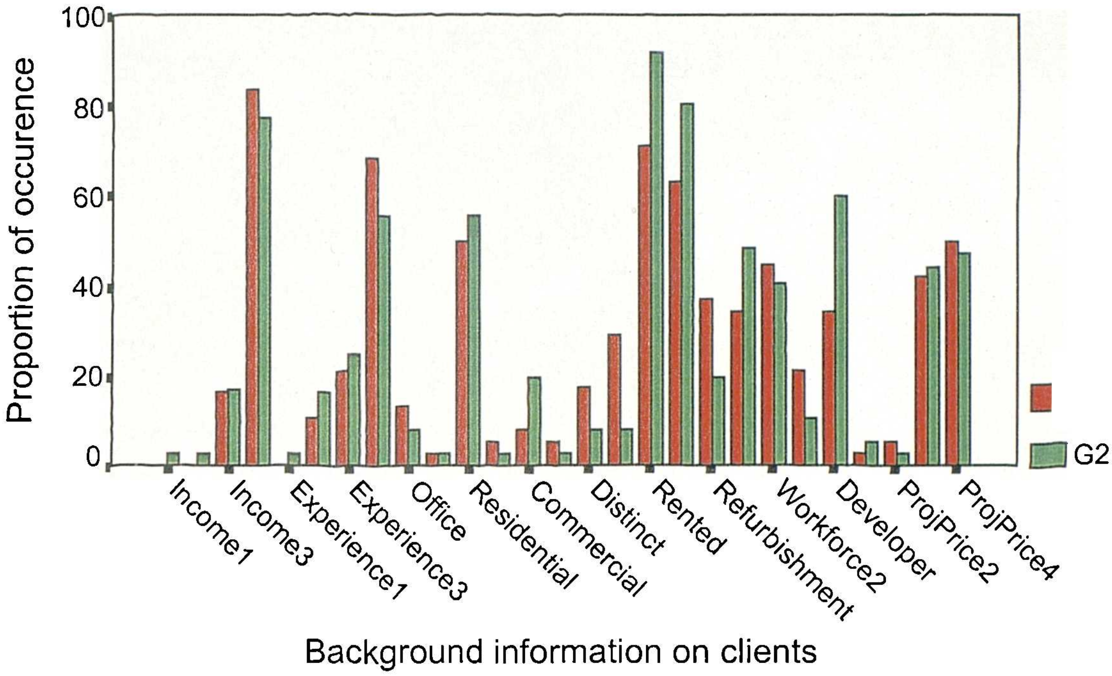


Figure 4.3 : Proportionate distribution of the characteristics of G1 and G2

4.9 Outstanding information for the research

It has been reiterated in this chapter that two main types of information were elicited in the research, namely: clients' needs; and, factors underpinning them. The first questionnaire elicited information on clients' needs but not on the factors underpinning them. A second questionnaire was prepared to collect information on these factors. The information generated through this second questionnaire enhanced analysis toward resolving the fourth and final main hypothesis.

The split-approach in the task of data collection was adopted because of three reasons. The first, being that if one questionnaire had been used, it would have been loaded, requiring each respondent to spend a longer time in supplying all the information. This might have had the negative effect of dissuading some clients from responding to the request for information. Thus the split-questionnaires provided a break to the respondents.

The second reason pertained to the issue of precision (see: section 4.2). Part of the first phase of the research studied the clients' responses for reliability where information from clients who provided a high level of unreliable information in the first questionnaire were dropped from the study (see chapter 5). If a client had provided unreliable information concerning his/her/their construction needs, it is possible that the same thing would happen in the course of providing information in respect of factors underpinning the needs. It was therefore decided that the first set of information collected through the first questionnaire be analysed prior to collecting the second set. In using the second questionnaire to collect information on factors underpinning needs, only those clients who were judged to have provided reliable information were requested to supply information concerning the factors, which influenced their needs.

The third reason for using two sets of questionnaires concerned the multi-stage sampling adopted in the research. Depending on the outcome of the (impending) purposive sampling, some clients or even groups of clients might not be sampled for further studies. Thus if information on factors influencing clients' needs were collected from all clients and some of them were not eventually sampled in the second phase, their information would be redundant. The collection of information on factors underpinning clients' needs was therefore delayed until some/all clients had been sampled for the second phase of the study.

4.10 The Second Questionnaire

The information generated in the second questionnaire concerned the magnitude with which some factors underpinned clients' needs-preferences. The intent was that, by determining the most influential factors, which influenced clients' needs, the research would provide a basis for determining and/or verifying clients' requirements in project undertakings.

A checklist of attributes, which can influence clients' preferences concerning project requirements, was generated from literature. The attributes generated and the sources from which they were obtained are shown in Table 4.11.

The checklist in Table 4.11 formed the main basis upon which the second questionnaire was developed. The identified attributes were formatted into a Table, which was preceded by an introduction. Clients were asked to rate how much each attribute influenced their desire of needs as reflected in their response to the first questionnaire. A likert type of scale was used in eliciting the clients' opinions. As with the first questionnaire, clients were allowed space to specify unidentified attributes and to comment on the research. The questionnaire developed is shown in Appendix D.

Table 4.11 : Checklist of potential attributes influencing clients' construction needs

1) Organisational identity (Sekaran, 1992)
2) Business function (Sekaran, 1992)
3) Size of organisation (Gutman, 1988; Sekaran, 1992)
4) Number of employees (Ariba, 1990)
5) Status of employees (Ariba, 1990)
6) Type of facility to be built (project related attribute)
7) Type of development: new or refurbishment (project related attribute)
8) Size of building(s) and/or rooms (Ariba, 1990)
9) Type of clients/customers (Ariba, 1990)
10) Expressed desires of clients/customers (Ariba, 1990)
11) Public opinion concerning building product/materials (Ariba, 1990)
12) Public perception of the client/organisation (Ariba, 1990)
13) Needs of other users of the facility (Ariba, 1990; Worthington, 1994)
14) Special users' (e.g. disabled, etc.) needs (Bishop, 1984)
15) Specifications of consultants (Bishop, 1984)
16) Advise of in-house professionals (Bishop, 1984)
17) Planning regulations (Ariba, 1990; Burt, 1978)
18) Building regulations (Ariba, 1990; Burt, 1978)
19) Competition with rivals (Bishop, 1984)
20) Personal taste of company owners/directors (Ariba, 1990; Gutman, 1988)
21) Personal taste of a designated project officer (Ariba, 1990; Gutman, 1988)
22) Aggregated taste of management staff (Ariba, 1990; Gutman, 1988)
23) Aggregated taste of company employees (Ariba, 1990; Sekaran, 1992)

4.10.1 Piloting the second questionnaire

The formulated questionnaire was piloted for efficacy with a Nationally renown Insurance Company that is involved in property development. This client had not participated in the first phase of the research, and, its response is shown in Appendix E. No express reservations about the questionnaire were made by this company. In view of this, more attributes were not added unto the compilation due to parsimonious considerations. It was also felt that clients should be allowed to name any unidentified and peculiar attributes in addition to those already compiled. Thus the developed questionnaire was sent out to clients who were already identified, that is, members of G1 and G2 (see Table 4.9).

4.10.2 Administration of the second Questionnaire

The second questionnaire was sent only to clients belonging to groups G1 and G2. The number of questionnaires sent was thus 75, with the breakdown of 38 to G1 clients; and, 37 to members of G2. The questionnaires were despatched within the first week of June 1998, after the clients' needs had been scaled.

The administration of the second questionnaire was delayed for a long time due to difficulties that were encountered in the analysis of data arising from the first questionnaire. These analyses (reported in Chapters 5,6 and 7) were much more difficult than anticipated, and, it was necessary to complete the first set of analysis before proceeding to the second. Notably, chapter 5 concerns the supply of reliable information by construction clients. If a client had supplied unreliable information in the first questionnaire, it is most likely that the information such a client would provide in the second questionnaire would equally by unreliable. Thus it was vital that information supplied through the first questionnaire be analysed before proceeding to the second questionnaire. In view of sampling size(s), it was also necessary that clients be classified into needs-based groups prior to identifying and selecting those groups that would supply data in the second phase of the investigation.

The aforementioned analyses in Chapters 5 to 7 were conducted between the period of June 1997 and April 1998 while the second questionnaire was equally developed. The month of May 1998 was used in piloting and revising the second questionnaire. In administering this questionnaire, names and addresses of members of G1 and G2 were collated from the responses indicated in the first questionnaire and used in approaching them with the second questionnaire.

The long interlude between the administration of tne two questionnaires might raise a concern over the coherence of information expressed by each client in the separate questionnaires. That is to say, the needs of the clients could have changed sequel to expressing their priorities in the first questionnaire and prior to indicating, in the second questionnaire, factors, which influenced their requirements. Such a change could have a potential effect on the correlation between the two sets of information. This scenario was anticipated, and an effort to avoid its consequences was made.

Given that clients could embark on several construction schemes, respondents were asked to report on only one project, which was to be chosen and identified by each client. Section 4.7.6 showed that almost three-quarters (71.54 %) of the respondents, reported on projects that had been completed. By the time responses were made, these clients might have progressed unto other projects, where their priorities had changed. Thus the adequacy of information supplied by the clients rested on their ability to recollect past events. In this regard, Section 1.6 assumed that the clients were apt to supply the information expected from them. Given that construction products require large financial outlays (Allen, 1984; Hughes, 1992a), and, form a major part of clients' durable assets (Duffy, 1974; Chartered Institute of Building, 1980), it was not inappropriate to assume that clients would remember facts and figures concerning their construction undertakings. The research thus dealt with the information supplied by the clients on the basis that it was genuine.

Therefore, if the clients could supply information on their (past) project needs, it was also possible for them to identify, on a retrospective basis, the factors which underpinned those needs. In this regard, it is not the dynamic nature of clients' preferences that is most important, but the ability to recollect the past. Since most clients voluntarily chose to report on past and not current projects, the time interval between the administration of the two questionnaires would have had little or no effect on the coherence of the dual responses of the clients.

While it is possible that the needs of the clients might have changed by June1998, when the second questionnaire was administered, information on this research was generally supplied in respect of previous projects, which the clients had specifically chosen themselves. The decision of most clients to report on previous, and not present projects, was thus accepted with the supposition that adequate information was (to be) provided by the respondents. However, to avoid any mix-up in answering the second questionnaire, copies of the needs upon which information was supplied in the first questionnaire were sent to the clients along with the second questionnaire. This pro-active effort was aimed at reminding the clients the basis on which they were to answer the second questionnaire. Thus, care was ensured, that the information obtained from the second questionnaire matched that from the first.

4.10.3 Responses obtained from the second questionnaire survey

Three weeks after sending out the questionnaires, 31 were received back from clients who had completed them. In order to get more responses and to ensure that clients who were willing to complete and return their questionnaires had not forgotten, a reminder was sent to those who had not replied. Essentially another copy of the questionnaire was despatched together with another covering letter. This was done in the first week of July 1998. Further on this action, 22 more completed questionnaires were received. Thus in all, 53 questionnaires were collected back in the second phase of information generation which was terminated at the end of July 1998.

The 53 respondents represent 70.67% of those from whom information was requested. The respondents were divided between G1 and G2 in the ratio 29:24. The remaining 22 clients (29.33%) who did not reply might have relocated or grown passive due to the relatively long time that had elapsed since the administration of the first questionnaire.

4.10.4 Screening of client data

The structure of the second questionnaire is such that completing it was more straightforward than its predecessor. Its screening involved checking that the respondents had rated the given attributes. The screening also sought for comments made and additional attributes identified by the respondents.

All responding clients completed the questionnaire, though some attributes were occasionally, not scored by a few clients. A small number of respondents identified a few additional attributes, which they claimed were influences on their needs. However, no client made any comment or offered further suggestions concerning the research.

4.10.5 Preview of the treatment of data obtained through the second questionnaire

The rating of attributes in the second questionnaire by the clients was aggregated at group level using descriptive statistics (see Chapter 7). The analyses of chapter 8 then considered differences between G1 and G2 in the rating of these attributes. The predominant attributes that were identified were categorised into four factors, where associations between clients' critical needs and these factors were made. The details of these analyses are reported in chapter 8.

4.11 Research procedure

The report in this chapter does not reflect the chronological sequence in which the issues discussed were encountered or executed. Therefore this section gives an overview of the way the investigation was conducted to forestall any mix-up in the understanding of the contents of this chapter. The following steps describe the sequence in which the investigation was conducted.

1. A checklist of clients' requirements was generated both via a literature search and an empirical client-survey. The checklist is potentially useful as a source for jogging clients' memories in identifying their needs.
2. Clients were initially invited for participation in the research via 'non-probability' and 'convenience' sampling.
3. The meanings and preferences attached to identified needs were elicited from the sampled clients.
4. The information supplied by the clients was analysed for reliability wherein grave

inconsistencies expressed by the clients were investigated.

5. Using their expressed preferences, the sampled clients were stratified into needs-based homogenous groups wherein cluster analysis was employed.
6. Two of the homogenous groups of clients were purposely sampled for further investigation in the course of the research.
7. The values of the sampled groups of clients, (in terms of needs), were scaled by the psychometric instrument of paired-comparison.
8. The critical needs of the two groups of clients were identified and compared to determine their difference(s).
9. Potential attributes, which could influence clients' values, were generated both from literature and an empirical survey of construction clients.
10. The influence exerted by each identified attribute on each client group was measured using descriptive statistics.
11. Through the rating of attributes, predominant factors impacting on the two clients' project requirements were established through statistical analysis.
12. The critical needs of clients were linked with the predominant factors that were identified.
13. Conclusions were made in accordance with the observations of the experiment.

4.12 Summary

The research employed quantitative survey as the main methodology for conducting the investigation. A cross-sectional comparative study was outlined as the accompanying research design. The choice of this research strategy was based on the nature of the data, precedent works and theoretical criteria.

Two questionnaires were employed in collecting all the data needed for the investigation. The first questionnaire was developed to collect data on clients' needs. The administration of this questionnaire generated a response rate of 22.32%. After screening clients' responses the information supplied by 123 clients were accepted for consideration in the study. The frequencies by which various meanings of needs were desired by these 123 clients showed a staggered variation. The second questionnaire collected data in respect of attributes, which influenced clients' needs. Some selected clients rated the impact, which the attributes had on their construction needs.

Having outlined the data used in the investigation; explained how they were acquired; and, previewed how they were analysed, the requirements of a research methodology as defined in section 4.1 have been fulfilled. The research data and their analyses involved elaborate considerations, which could not be reported in one chapter, and so, were reserved for subsequent chapters. In this respect chapter 7 explains how part of the data were measured while chapters 5, 6 and 8 concentrate on the analyses.

CHAPTER 5

CONSTRUCTION CLIENTS' INCONSISTENCY IN MAKING PREFERENCE JUDGEMENTS

CHAPTER 5 : CONSTRUCTION CLIENTS' INCONSISTENCY IN MAKING PREFERENCE JUDGEMENTS

5.1 Introduction

This chapter reports the analysis in respect of the first main hypothesis. The analysis sought to check if construction clients do provide reliable information in connection with their project requirements. This was done because, if clients do supply inaccurate information, then project disputes and failures can (partially) be linked to such bad information.

Communication is a very broad subject and all its aspects cannot be covered in a dissertation of this nature. Thus due to a parsimonious consideration, only an aspect of communication was examined, which is, the consistency with which clients made preference choices. This type of analysis has the benefit of showing the reliability (goodness/badness) of a piece of information that has been supplied by a client. It also provides a foundation for the considerations in chapter 7 where clients' values are measured.

5.2 Inconsistency in decision making

To say that someone has a set of consistent preferences implies that he/she is capable of expressing a consistent order of preferences over a set of outcomes (Hogarth, 1980). For any given three stimuli (x, y and z), consistency in the relative preferences of these stimuli would mean that (Raiffa, 1968; Lindgren, 1971; French, 1989):

$$\text{if } X > Y \text{ and } Y > Z, \text{ then } X > Z.$$

where, the symbol ">" means: "is preferred to".

(In)consistency is probably the right word for describing the foregoing concept (Kendall, 1970), but, unfortunately it has other technical meanings in both logic and statistics (Lindley, 1971).

To avoid confusion therefore, two other terms by which the concept is equally known will henceforth be used. These are "transitivity" (Gulliksen and Tucker, 1961); and, "circular triad" (Dunn-Rankin, 1983).

5.2.1 Causes of intransitive judgements

Intransitive preferences can come about by (Kendall and Babington Smith, 1939):

- a misunderstanding of the questions being answered;
- memory failure;
- incompetence of the judge; and,
- indistinguishability of stimuli.

Uncertainty, indecision and choices involving conflicting dimensions are other reasons that could lead to intransitive judgements (Hogarth, 1980). A further reason that has been advanced as giving rise to intransitive judgements is guessing on the part of decision makers (David, 1969).

By some of these causes, it can be understood that on face value, the making of intransitive choices by a decision-maker does not necessarily mean that such person is making unintelligent judgements. Thus, in analytical considerations, it is the gravity of the intransitivity that is first judged. While minimal amounts of intransitivity can be condoned or redressed as the case may warrant, a high amount of intransitivity calls for more drastic action.

5.2.2 Why intransitivity was analysed in this research

Chapter 1 indicated that the research was partly concerned with the quality of information supplied by construction clients, whether it was reliable or not. High intransitive judgements by construction clients may mean that they are finding it difficult or impossible to distinguish between paired needs and cannot therefore order their project requirements properly. This would in turn mean that: i) due to bad judgement some clients could, *inter alia* be supplying wrong information for project decision making; and, ii) the information supplied by clients cannot be accepted first hand without verification or moderation. If on the other hand clients are transitive in their judgements, then the project information they supply could be upheld as reliable and their expressed needs-desires should not be treated with scepticism.

Intransitive preferences are a potential source of misrepresentation which could hamper the evaluation of stimuli by paired-comparisons, the method adopted in chapter 2. If therefore a high or suspicious level of intransitivity is discovered in the course of making choices, its origin should be established and its effect should be investigated or corrected (Tversky, 1977). To this end the magnitude of intransitive choices made by clients in this research was evaluated. Paired-comparisons as employed in Section-C of the first questionnaire, provided an avenue for analysing the express desires of the clients in search of intransitive choices (David, 1969; Kendall, 1970).

5.2.3 Analytical procedure employed for evaluating intransitivity

To proceed with the analysis, the 8 needs (stimuli) of aesthetics, economy, functionality, quality, relations, safety, lack of surprises and time were first combined into groups of different three's (triads). The preference-choices of each client over each triadic combination were then analysed to check for intransitive judgements, as per the illustration of section 5.1. Triadic combinations were considered for the analysis because, pair combinations do not directly reveal intransitive choices, and, any other higher combination of stimuli can be reduced to triads (Kendall, 1970).

The minimum possible number of circular triads that one judge can make is zero and the maximum, where an even number of stimuli is involved, is given by the formula (Kendall and Babington-Smith, 1939):

$$\left(\frac{n^3 - 4n}{24}\right),$$

where, n is the number of stimuli.

By this formula, the maximum number of intransitive choices that a client could have made in the research, where n was 8, was:

$$(512 - 32)/24 = 20.$$

The range of intransitive judgements expected from each client in this research was thus: 0 - 20.

This range provides a basis upon which the intransitive choices of the clients will be assessed.

5.2.4 Assistance of the computer in searching for intransitive choices made by clients

The number of circular triads made by each client can be ascertained by manual checks. However, with 8 stimuli under investigation there were 56 triadic combinations to be verified for each client. 56 was obtained from the combinatorial formula (Dunn-Rankin, 1983):

$$\binom{N}{3} = \frac{N(N-1)(N-2)}{6},$$

where: N is the number of stimuli.

Having acquired information from a sample of construction clients and screened their information, chapter 4 (tentatively) upheld the information of 123 clients. It was the data of these clients that were analysed for transitivity of preference-choices. The information used for the analysis was obtained from Section C of the first questionnaire, as completed by the clients.

Thus, there were possibly, 56 X 123 = 6,888 triads to be analysed for all the 123 aforementioned clients. Cross-checking (6,888) triads manually could be daunting, inconvenient and time consuming (David, 1969). In a bid to curtail manual labour, a computer program was developed to assist in spotting the intransitive preferences made by the clients. The program was written in SQL and ran on the SAS software. The programme is reproduced in Appendix F.

The preference-choices made by the clients in completing Section-C of the first questionnaire were recorded on a spreadsheet; and, the developed programme was applied on these choices to spot-check intransitive choices. The program detected and recorded each respondent's number of intransitive choices. Appendix G gives the computer output while Table 5.1 provides a summary of its result.

Although the output of the analysis in Appendix G concerns 131 clients, numerical values in Table 5.1 are in respect of the 123 clients whose data were accepted for this purpose in Chapter 4. Appendix G evaluated the information of those that completed Section-C partially, hence the difference in the number of clients shown there. Table 5.1 indicates that 50 clients (40.65% of 123) made no intransitive choices at all. Of the remaining 73 clients, only 6 of them (4.88%) made more than 10 intransitive choices, and, only one client made the maximum possible number of intransitive choices (20).

Table 5.1 : Performance of clients in terms of making intransitive choices

Number of Intransitive choices	Frequency	Cumulative Number of Intransitive choices	Percentage of clients	Cumulative Frequency	Cumulative Percentage
0	50	0	40.65	50	40.65
1	16	16	13.01	66	53.66
2	14	44	11.38	80	65.04
3	12	80	9.76	92	74.80
4	8	112	6.50	100	81.30
5	6	142	4.88	106	86.18
6	5	172	4.07	111	90.25
7	2	184	1.63	113	91.88
8	2	200	1.63	115	93.51
9	2	218	1.63	117	95.14
12	1	230	0.81	118	95.95
13	1	243	0.81	119	96.76
14	3	257	2.44	122	99.20
20	1	277	0.81	123	100.01

There is a theoretical basis for assessing the gravity of each client's level of intransitivity. If it is employed as a yardstick of an assessment, each client's level of intransitivity can be designated as low or high. This theoretical knowledge was applied in assessing the magnitude of each client's intransitivity. Invariably the assessment can be made for either individuals or groups (Dunn-Rankin, 1983).

5.3 Assessing the gravity of the intransitivity choices of the clients as individuals

The gravity of each client's intransitivity was assessed by statistical analysis. In this regard, the set of statistical hypotheses tested were:

H_0 : Construction clients are highly intransitive while making pair-comparison choices: and,

H_1 : Construction clients are transitive while making pair-comparison choices.

The gravity of intransitivity made by each client was assessed via the 'coefficient of consistence', which is a scale used in portraying one's degree of intransitivity. The coefficient is established from a formula, which is given as (Kendall and Babington-Smith, 1939):

$$\zeta = 1 - \left(\frac{24d}{n^3 - 4n}\right), \text{ where:}$$

ζ is coefficient of consistence;

d is the number of intransitive triads; and

n is the number of stimuli, (where n is even).

The coefficient of consistence ranges from 0.00 to 1.00 where, a coefficient of 1.00 indicates perfect transitivity in choices while 0.00 connotes optimal intransitivity.

The coefficient of consistence 'ζ' of each client was computed and tested for its probability of occurrence by chance. In this concern Kendall (1970) tested '*d*' to approximate to a χ^2 distribution where:

$$\chi^2 = [\frac{8}{n-4} \{\frac{1}{4}\binom{n}{3} - d + \frac{1}{2}\} + v]$$

In this formula, 'v' refers to degrees of freedom, and, is in turn given by the formula:

$$v = \frac{n(n-1)(n-2)}{(n-4)^2}$$

In this investigation, $n = 8$, and, for the client with the highest number of circular triads, $d = 20$ (see Table 5.1). For this client therefore:

$$v = \frac{8 \times 7 \times 6}{4^2} = 21 \text{ ;}$$

$$\chi^2 = \frac{8}{4}\{\frac{1}{4}\left(\frac{8 \times 7 \times 6}{3 \times 2}\right) - 20 + \frac{1}{2}\} + 21 = 10 \text{ ; and,}$$

$$\zeta = 1 - \frac{24x20}{8^3 - 32} = 0.00.$$

To interpret these results the probability of a pair of 'ζ' and 'd' occurring by chance was used as a decision making yardstick. This probability can be computed from statistical (χ^2) tables.

One way of using the Tables is to ascertain the complement of the probability that corresponds to v and χ^2. In this regard, one goes down the first column of the χ^2 Table to the particular degrees of freedom (v). Along the row entry for that v, one finds the χ^2 value that (closely) matches that which has been computed through the foregoing formula. Projecting upward from that value, one reads the complimentary probability at the top row of the χ^2 Table. Being that the probability obtained from the Table is complimentary, the exact probability of occurrence of a calculated coefficient of consistence is finally obtained by subtracting the read probability from unity.

Alternatively, Kendall (1970) has made the foregoing process easier by producing a Table of exact values of the probabilities of 'ζ' for v ranging from 0 to 40 and for n ranging from 2 to 10. The usage of Kendall's Table was:

- illustrated in his book (see: *Example 11.2*, pp.147-8);
- easier to use; and,
- thus adopted in this analysis.

From the aforementioned Table (Kendall, 1970), the values of $v = 21$ and $n = 8$ equate to a probability that is virtually 0.00 for $d = 20$. It means that the probability of making 20 intransitive choices by chance when presented with 28 paired stimuli, is virtually zero.

The discussion of section 5.2.3 showed that the maximum possible number of intransitive choices that could be made where $n = 8$ was 20. This explains why the empirical probability of making 20 intransitive choices by chance is almost zero. Such a high level of intransitivity cannot be attributed to chance.

Since the number of intransitive choices made by the client was high and that the probability of making such a high level of intransitive choices by chance was equated to zero, it was concluded that the client had provided information that was highly unreliable. The outcome of the analysis of information from this particular client suggests that the null hypothesis be accepted.

The information supplied by all the other clients were likewise analysed following the foregoing procedure, and, noting the outcome on each occasion, as to whether the null hypothesis should be accepted or rejected. To avoid repetitions, the subsequent analyses were collated, and their outcomes are presented in the summary of Table 5.2. The probability by which the number of intransitive choices could have been made by chance by each set of clients is shown in the fourth column of the Table.

A threshold value needs to be established to help delineate whether a given amount of intransitivity is attributable to chance or not. Tests for circular triads are generally significant at the 0.95% level (Dunn-Ranking, 1983), and, this level of significance is generally acceptable for social science research (Sekaran, 1992). Therefore, if a threshold level of significance of 0.95 is considered for the results of Table 5.2, then only clients whose information contained more than 8 circular triads should be considered as highly intransitive, (refer to Table 5.1). It also means that only the preferences of 8 clients (6.50%) should on this basis be discarded as being statistically unreliable, as their intransitivity cannot be attributed to chance.

Table 5.2: Probability of making intransitive judgements by chance with 28 pairs of stimuli

Number of intransitive choices (*d*)	Coefficient of Consistence (ζ)	χ^2 (For $v = 21$)	Probability of making intransitive choices by chance	Remarks
20	0.00	10.00	<0.012	} High
14	0.30	22.00	0.610	} amount of
13	0.35	24.00	0.701	} intransitivity
12	0.40	26.00	0.792	
9	0.55	32.00	0.937	
	Threshold value of probability		*= 0.95*	
8	0.60	34.00	0.963	} Acceptable
7	0.65	36.00	0.977	} amount of
6	0.70	38.00	0.989	} intransitivity
5	0.75	40.00	$0.9^{2}36$	
4	0.80	42.00	$0.9^{2}72$	
3	0.85	44.00	$0.9^{2}87$	
2	0.90	46.00	$0.9^{3}55$	
1	0.95	48.00	$0.9^{3}85$	
0	1.00	50.00	1.000	

The inference is that the null hypothesis should be rejected most of the time (93.50%) and accepted only on a few occasions (6.50%). From the foregoing explanation it can be suggested that the 8 clients who made more than 8 intransitive preference-choices have provided information that is highly unreliable. It would be better if their responses were omitted in further considerations in this research.

Practically, (high) intransitivity should be cross-checked with the affected clients. Being that the number of clients with very high intransitivity in this particular research was small further investigation was not pursued. Rather, the information supplied by these eight clients was simply not considered in the subsequent evaluations of the research.

5.4 Discussion

The analyses indicate that some clients were capable of making transitive choices while others were not. Although the clients who participated in the research differed in terms of their respective preferences many of them were statistically transitive in expressing their individual desires. The discussions in chapter 3 recommended that professionals should help clients to identify their needs more accurately. The result of the analysis in this chapter suggests that, given (little) assistance from construction professionals, clients could provide concise and transitive information concerning their needs.

However being that only 40.65% of the sampled clients were completely transitive suggests that client-information should always be checked for clarity, accuracy and reliability. This is particularly applicable where rank data will be used, for one intransitive triad can misrepresent the ranking attached to a set of needs by a client.

The research adopted a significance level of 0.95% in delineating whether the extent of intransitivity produced by the clients should be accepted or not. While this threshold level might be acceptable for psychological scaling to which the clients' information will further be used, it might be optimistic for decision-making purposes. In practice, an analyst using the techniques herein adopted might want to use a more stringent value. However, the 0.95% threshold receives a wide acceptance in statistical considerations and was adopted for the research considerations.

The clients studied were mostly transitive in their choices probably because of their experience with construction undertakings. With most of them having procured and taken over several construction projects in the last five years (see: Table 4.6), they would have gained a greater understanding of their requirements and can thus state them concisely. These clients might have learned their needs along the line, probably making mistakes in the process, and could in retrospect specify their requirements more accurately. The same clients might not have produced a high level of transitivity when they started procuring construction projects. By the same analogy, newer clients who have no experience with construction might not be highly transitive as those studied. It may thus mean that experience helps clients to understand construction issues better.

5.5 Summary

The chapter evaluated the information supplied by some construction clients, to check if they were consistent in stating their preferences. Having solicited the clients' preferences through pair-comparisons, the psychometric tool of circular triads was statistically used in assessing the gravity of each client's intransitivity. In general the analyses indicate that 40.65% of the sampled clients were absolutely transitive in expressing their needs. A further 52.85% were marginally intransitive, and, 6.50% of the clients were grossly intransitive in their pair-comparison choices. Thus, it can be asserted that most of the clients who participated in the research provided, relatively unreliable information, albeit some marginally.

Having applied the concept of intransitivity in checking the preference-choices of the clients, eight clients were considered to have made very high intransitive decisions. As these were unacceptable, their responses were dropped in the course of proceeding analyses. Thus the total number of responses dropped in the course of the research rose to: (10 + 8) = 18. By dropping these 18 from the initial 133 respondents, the research was left with 115 clients. It is the preferences expressed by these 115 remaining clients that were upheld as being reliable for the next aspect of the analysis. In this light it is the preferences of these 115 clients that are reflected in Appendix C.

CHAPTER 6

A NEEDS BASED CLASSIFICATION OF CONSTRUCTION CLIENTS

CHAPTER 6 : A NEEDS BASED CLASSIFICATION OF CONSTRUCTION CLIENTS

6.1 Introduction

By convenience sampling the first questionnaire was administered where data on clients' needs were collected. Having analysed part of these data in chapter 5, the present chapter continues with the analyses, by evaluating the preferences of the clients, to investigate for prospective similarities between them. The analysis of this chapter addresses the second main hypothesis declared in section 4.3, i.e., that 'the values of construction clients are the same'. In studying the similarity of clients' preferences, cluster analysis was employed as a statistical tool. The essence of a cluster analysis is to classify a set of objects/subjects, if possible, into homogenous subsets. The feasibility of a classification depends, *inta alia*, on the similarity of the entities to be classified.

The cluster analysis in this research was performed using the information of the 115 construction clients whose data were adjudged in chapter 5 to be (statistically) reliable. The outlay of the priorities of these clients is presented in Appendix C. Section 6.2 concerns a review of empirical classification, as a framework for the analysis. Section 6.3 serves three purposes, viz: it provides further details on classification; explains the concept of cluster analysis; and, classifies construction clients into needs-based groups.

6.2 Empirical classification

Classification is the grouping of objects on the basis of their similarity (Clifford and Stephenson, 1975). Classification must have started with human origin and is generally regarded as being part of natural human endeavour (Good, 1965). Although classification can be done intuitively an objective approach is deemed to be better (Sneath, 1965; Gordon, 1981; Arabie and Hubert, 1996b).

Thus empirical classification was developed for the grouping of objects on the basis of their relationships (Sneath and Sokal, 1973). The objective of empirical classification is to discover the natural groupings in a data set such that objects of each class are more similar to each other than those of other classes (Gordon, 1996).

Aristotle is regarded as the pioneer of empirical classification (Good, 1965), having developed a system for classifying human species (Everitt, 1993). Classification was principally developed for classifying plants and animals, but its principles can be applied to any other field (Sneath, 1965). Indeed empirical classification has extended beyond these initial bounds with literature on its application currently being found in the fields of marketing, psychology, sociology, archaeology, ecology, soil science, etc. (Gower, 1988).

The benefits of classification include:

1. It enhances the simplification of data by reducing its dimensionality (Gnanadesikan, 1977).
2. It allows multiple groups in a population to be identified and named and their properties investigated. Accordingly this benefit provides a basis for forecasting and formulating hypotheses (Hartigan, 1975).
3. It aids communication and mental visualisation (Good, 1965).

On the other hand there are setbacks that can accompany a classification and these include:

1. When more than one attribute is considered, it becomes difficult to cluster members into exclusive groups if they share some characteristics.
2. The contemporary clustering algorithms do not produce concordant results even for a particular datum (Hubert and Arabie, 1996b);
3. There aspect of validating clustering outcomes has remained underdeveloped (Gordon, 1996).

6.2.1 Types of classification

There are two main approaches to classification (clustering) namely: *Divisive* and *Agglomerative* (Davison, 1983). Divisive clustering starts with one group composing of all members, and, based on their differences, this initial group is divided into two. The two new groups are in turn subdivided into further sub-groups. The division continues until a desired stage is reached.

An agglomerative technique on the other hand adds members unto groups as the clustering is done (Clifford and Stephenson, 1975). This type of clustering starts by taking two clients that are most similar to each other, and combines them to form a single cluster. Several sets of two or more clients can be combined simultaneously, if their degrees of similarity are judged to be the same. The next step in the agglomeration is to further combine groups, or, groups and individuals, on the basis of communality. The combination continues progressively until all emerging groups have been combined into one big cluster. This type of combination is referred to as hierachical classification (Cormack, 1971) and it implies that as members are added, cluster membership increases and the number of emerging groups successively diminishes. The hierarchy starts with a broad base of individuals, and, thins up at the apex with only one main group. Hierarchical classification is often used (Davison, 1983; Rosenberg et al., 1996) and was in this wise employed in this research.

The next type of classification describes the clustering as either *Monothetic* or *Polytethic* (Howard, 1991). In monothetic clustering classes differ by at least one property while in polythetic clustering the groups are distinct on several properties. The classification in this chapter is polythetic.

Classes can either be *exclusive* or *overlapping* (Good, 1965; Rosenberg et al., 1996). In exclusive classification each member is stratified to belong to only one group whereas in overlapping clustering (clumping) a member can belong to more than one group at the same time (Cormack, 1971). Clumping is possible in polythetic classifications where some members have characteristics that are shared by two or more groups. In connection with this dimension, Zadeh (1977) indicated that classes could either be distinct or fuzzy. In fuzzy clustering the boundary between two classes is not sharply defined. Only exclusive classification was considered in the present research due to the capability of software available for classification.

6.2.2 Displaying the results of a classification

Clustering results are displayed in a dendrogram (Sneath, 1965) which is a tree-form diagrammatic representation (Krzanowski, 1988). It shows how members of a group have been hierarchically combined or divided by a chosen algorithm, but, no compact groups are specified in it. To delineate clusters in a dendrogram a stopping rule is used. Stopping rules are discussed later (see section 6.3.4), as the classification procedure employed is reported.

6.2.3 The how of classification

Empirical classification involves the following four steps (Sneath, 1965):

1. Choice of subjects/objects to be classified;
2. Choice of criteria to use in denoting the resemblance of members;
3. Clustering of the objects on the basis of their similarities; and,
4. Studying their properties for distinctiveness.

The subjects classified in this investigation were the 115 construction clients that were identified in chapter 5. The criteria used for classifying them were their needs-priorities, as expressed by the clients in section-C of the first questionnaire. The clustering of the clients into needs-based groups and the tools utilised are discussed fully in Section 6.3, while the properties of some of the emerging groups are evaluated in chapter 7 and analysed in chapter 8.

6.2.4 Tools for empirical classification

Cluster analysis is the main analytical tool used in classification. However, data reduction techniques like factor analysis, principal components analysis, multidimensional scaling, etc., are available as a rough guide to a classification. An attempt to visualise the possible grouping of the 115 clients was made using multidimensional scaling. The SPSS software employed could not cope with the large number of clients involved and the effort was aborted leading to the sole usage of cluster analysis in the classification.

There are several computer packages, which can perform cluster analysis and these include (Everitt, 1993) SAS, MINITAB, BMDP, SPSS, CLUSTAN and NTSYS. SPSS, (Version 6.0) was used in the clustering of the present research because it was readily available and accessible to the investigator. Its added advantage is that it is easy to use. Its programme that supports cluster analysis is known as ALSCAL.

6.3 A needs-based classification of 115 construction clients

Cluster analysis was used to delineate the 115 clients into needs-based homogenous sub-groups. The cluster analysis was performed by means of a hierarchical agglomerative non-overlapping technique (Howard, 1991). The following discussion describes the clustering.

6.3.1 Proximity coefficients

The first aspect of the analysis was to assess the relationships between the 115 clients in terms of their needs-preferences. These relationships were calculated by proximity coefficients, which denoted how dissimilar the clients were, with respect to each other, over the eight needs (attributes) considered.

There are several formulae for calculating proximity coefficients with some being suitable for calculating levels of similarity while others are useful for ascertaining dissimilarity. Either similarity or dissimilarity coefficients could be used in a classification. If similarity coefficients are used, ALSCAL will combine members on the basis of highest coefficient(s). If on the other hand dissimilarity coefficients are used, ALSCAL will combine members on the basis of least dissimilar coefficients. Thus, one needs to specify the type of coefficients being used in a particular classification.

The dissimilarity coefficients supported by ALSCAL (for interval data) include:

1. Squared Euclidean Distance;

2. Chebychev;
3. Block-City; and,
4. Minkowski.

Cormack (1971) gives a more detail listing of other coefficients. Given that several coefficients have been proffered and are available, an analyst can have difficulty in choosing one for a particular analysis. A simple heuristic guide proffered by Sneath and Sokal (1973) is to use the simplest coefficient that is applicable to a data set.

The 'proximity coefficients' between the 115 clients of the present investigation were computed using the 'Block-City' dissimilarity coefficient, which is given by the formula:

$$\text{Distance } (X,Y) = \Sigma_i \, |(X_i - Y_i)|, \text{ where;}$$

Distance (X,Y) is the Euclidean distance between client X and Y; and,

X_i, Y_i are respective ratings of the ith need by the clients.

Following a recommendation by Rosenberg et al. (1996), choice of the Block-City coefficient was based on an "*ad-hoc* consideration". Some of the issues considered in doing so were its simplicity and efficacy, having tried and compared its performance with other coefficients, prior to its selection.

There are three types of proximity coefficients, with each type pertaining to interval, frequency or binary data (Norusis, 1994). Notably, the data of Appendix C subscribes to frequencies, but the proximity coefficients meant for frequency data namely: 'Chi- and Phi-coefficients' could not match the performance of the Block-City coefficient in recovering homogenous groups of clients. It was on the basis of this comparative evaluation that the block-city formula was used in this investigation.

For any given set of members the matrix of coefficients of dissimilarity between them is symmetric with one half being the mirror image of the other (Sneath, 1965). SPSS thus gives only one half of the matrix, the lower half.

With 115 clients in the present research, there were 6,555 proximity coefficients between them. The value of 6,555 can be verified from the formula (Norusis, 1994):

$$\binom{N}{2} = \frac{N(N-1)}{2}\text{; where,}$$

N (= 115) refers the number of clients.

The nature of the SPSS output is such that these 6555 proximity coefficients were arranged in a rectangular matrix with the names (identities) of clients written across its top row and the same order of identities presented (downwards) in the first column. The inter-client dissimilarity coefficients were then indicated in the cells of the lower triangular half of the matrix. Appendix H shows the output of the cluster analysis where the 6,555 coefficients are also listed.

The values of the 6,555 coefficients will be used by ALSCAL as a basis for clustering the clients so that each group will consist of members that are more similar to each other and less alike to members of other groups. An algorithm facilitates the clustering.

6.3.2 Algorithms

Within the agglomerative approach there are several algorithms for combining subjects into groups. These algorithms aim at searching for the best set of groups that fits a given set of data (Hartigan, 1975). An algorithm specifies a criterion, either in form of a formula or heuristic, for grouping the objects. With the availability of computer facilities the algorithms employ an iterative approach in searching for an optimal solution.

The common algorithms available for clustering, which are available in ALSCAL, include the following methods (Gordon, 1981):

1. Between groups;
2. Single link (or nearest neighbour);
3. Average link (or within groups);
4. Furthest neighbour (or complete link);
5. Centroid clustering;

6. Median clustering; and,
7. 'Sum of squares' (or Ward's, 1963 method).

The different algorithms could produce different results for a particular classification, rendering the choice of any a difficult task (Arabie and Hubert, 1996b). A suggestion for overcoming this difficulty is to try two or three of them and choose the one that offers the best result (Everitt, 1993). In line with this suggestion all the algorithms supported by ALSCAL were tried in the present analysis wherein the one that resulted in the most homogenous set of groupings was eventually chosen (see Section 6.3.6). This better performing algorithm was found to be the "Average Link" method.

6.3.3 Analysis using the 'Average-Link' algorithm

An algorithm transforms proximity coefficients into distances which, are used in identifying the closeness of members relative to each other. Proximity coefficients will show that each member of the sample is related (either closely, moderately or weakly) to the other members. The transformation of the proximity coefficients into distances is to enable dendograms to be plotted, such that, those members that are most similar are plotted near each other while those that are least related are plotted further apart from each other. The yardstick of similarity, in this case, is open to different interpretations. Accordingly, the algorithms available for clustering differ from each other through the criteria they employ in grouping members.

The 'within-groups' method works on the distances between the members of differing groups, where average distances between the combination of members are used in delineating clusters (Norusis, 1994). This iteration would determine the optimum combination that produces least average distances within the groups established.

By specifying the 'within-groups' algorithm, ALSCAL produced the clustering dendrogram in Figure 6.1. The full clustering output is given in Appendix H. A dendrogram can be drawn either horizontally or vertically. The dendrogram in Figure 6.1 is particularly disposed in a sideways' (horizontal) view where, all clients are represented as single entities on its left hand side. As one progresses from the left to the right of this dendrogram, the individual clients are combined into various groups until all groups are merged into one big family at the extreme right.

Read at any position within the dendrogram, different numbers of client-groupings can be inferred. At the extreme left there are 115 groups, each composed of an individual client, while, at the extreme right there is just one big group of 115 clients. The overall disposition of Figure 6.1 is such that seemingly homogenous sub-groups of clients can be noticed. This disposition might be a trap as dendrograms are not interpreted by sight but by further empirical analysis.

6.3.4 Delineating clusters

To determine the groups in a dendrogram a further effort of evaluating for them has to be made. Clusters are delineated by what is known as 'stopping rules' which are formulae, which tell where groups can be demarcated in a dendrogram (Duda and Hart, 1973). The use of a formula to demarcate classes would mark the end of clustering.

Several stopping rules have been proposed with most of them giving different results for a given data set. By this characteristic, the choice of a stopping rule is done by a heuristic approach, as it was the case with the algorithms. Some simulation studies to compare the efficacy of some stopping rules have been reported. Amongst these studies, Milligan and Cooper's (1985), seems to be comprehensive having tested 30 different rules on a given study. To this end, their recommendation was used in choosing the rule that was employed in this investigation.

In Milligan and Cooper's experiment, 10 rules performed relatively well in recovering known classes in a data set. They then suggested that a choice of rule from amongst these 10 would (likely) give a better clustering outcome.

Dendrogram using Average Linkage (Within Group)

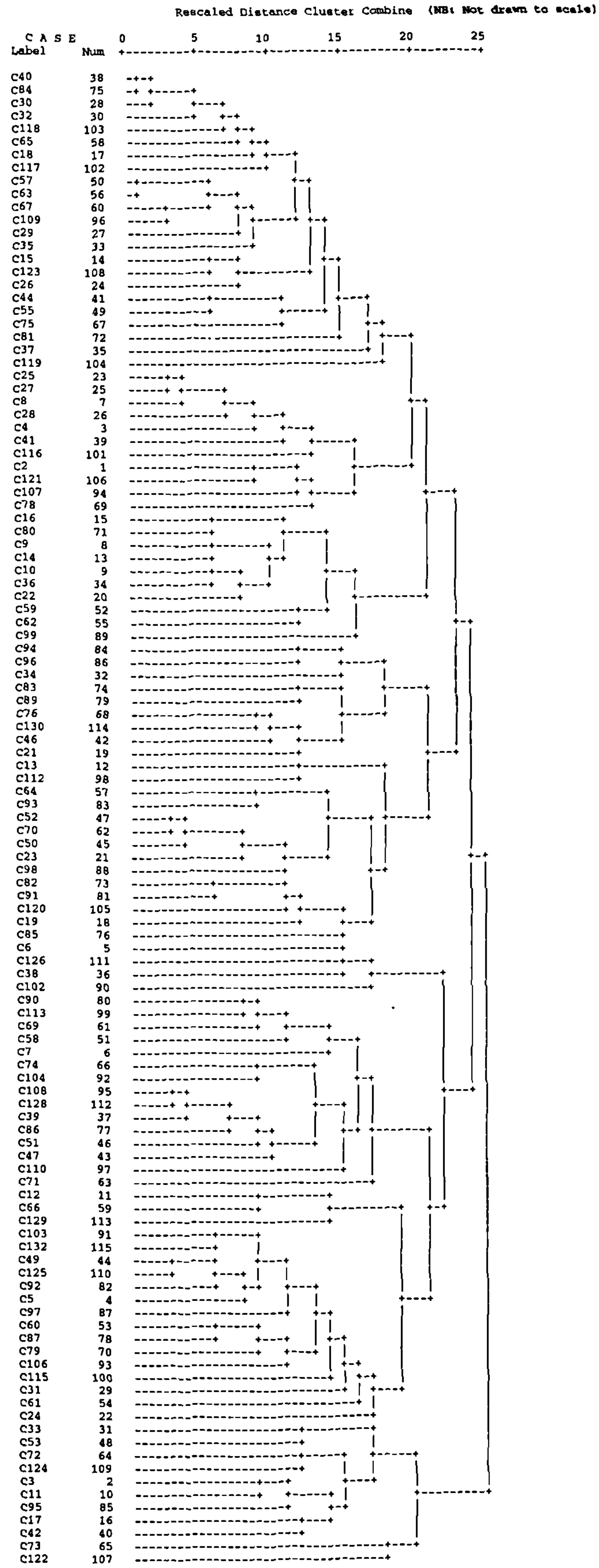


Figure 6.1 : Dendrogram showing the needs-based relationships between the clients

Within the 10 stopping rules recommended by Milligan and Cooper, one of them which has been tried by the researcher before (Chinyio et al., 1998a) was selected. This rule, which was described by Milligan and Cooper (1985) as being popular, is "Mojena's (1977) formula". Mojena's threshold-value-estimation function, demarcates the number of clusters at the point of fusion immediately preceding the location where the expression: $[f(\alpha+1) > \alpha' + K.\sigma]$ is first satisfied.

In Mojena's formula: $f(\alpha+1)$ is threshold fusion level;

α' is mean of fusion coefficients;

σ is standard deviation of fusion coefficients; and,

K is a constant, varying from 2.75 to 3.5 in steps of 0.25.

The fusion coefficients referenced above are the distances at which groups (or members) are combined by an algorithm. ALSCAL normally portrays these fusion coefficients as one of the by-products of a classification, so Appendix H shows the fusion coefficients in respect of the present classification.

If the foregoing expression (in Mojena's formula) is not satisfied at any fusion stage of the clustering, then no groups exist and objects of the classification can be treated as unique entities. By Mojena's argument, however, a range of clusters can be computed, since K is a variable. The minimum number of clusters would be obtained by using K = 3.50, while the maximum will be obtained by fixing K = 2.75. However, Milligan and Cooper (1985) performed iterations with values of K ranging from 1.00 to 3.50. In their experiment, the value of K that produced best results in terms of recovering known classes was K = 1.25. Taking a cue from this outcome, K = 1.25 was used in this study.

In applying Mojena's function, now revised with Milligan and Cooper's (1985) K-value, the fusion coefficients as produced by the classification output were employed. By means of 'compute' facility in SPSS, the statistical 'mean' and 'standard deviation' of the fusion coefficients were calculated to be:

$$\alpha' = 7.36; \text{ and, } \sigma = 3.64.$$

By substituting the foregoing values of α', σ, and K into Mojena's equation, it was found that the end of clustering should be at the point immediately preceding the fusion of client Nos. C32 and C19. This threshold stage determined the end of group merging and established the number of groups in the dendrogram. Its outcome suggested that 4 exclusive groups existed in the dendrogram, as shown in Figure 6.2. The composition of clients derived from Figure 6.2 is also shown on Table 6.1.

Table 6.1 : Distribution of 115 clients as classified by the 'within-group' algorithm

Group	Composition of clients
1	C40, C84, C30, C32, C118, C65, C18, C117, C57, C63, C67, C109, C29, C35, C15, C123, C26, C44, C55, C75, C81, C37, C119, C25, C27, C8, C28, C4, C41, C116, C2, C121, C107, C78, C16, C80, C9, C14, C10, C36, C22, C59, C62, C99 (44 in number)
2	C38, C102, C90, C113, C69, C58, C7, C74, C104, C108, C128, C39, C86, C51, C47, C110, C71, C12, C66, C129, C103, C132, C49, C125, C92, C5, C97, C60, C87, C79, C106, C115, C31, C61, C24, C6, C126 (37 in number)
3	C94, C96, C34, C83, C89, C76, C130, C46, C21, C13, C112, C64, C93, C52, C70, C50, C23, C98, C82, C91, C120, C19, C85 (23 in number)
4	C33, C53, C72, C124, C3, C11, C95, C17, C42, C73, C122 (11 in number)

6.3.5 Interpreting the cluster analysis results

Arabie and Hubert (1996b) suggested that "any selected solution be interpreted within the context of the area of research". The four groups of the foregoing cluster analysis should be interpreted as representing major groups of clients with each major group having its subgroups. The analogy that could be likened to this classification is the grouping of cars into major types like: Ford; Vauxhall; Peugeot; Fiat; etc. Each of these types of cars has its subgroups (See Table 6.2).

Each type of car has communality with other members of its family, though some of its sub-attributes may either differ or be the same with other types of cars. This level of classification is thus a macro grouping. Similarly, the grouping of clients in Table 6.1 denotes major groups, which correlate with their predominant needs.

Group 1 (G1) : Consisting of 44 clients (C_i)

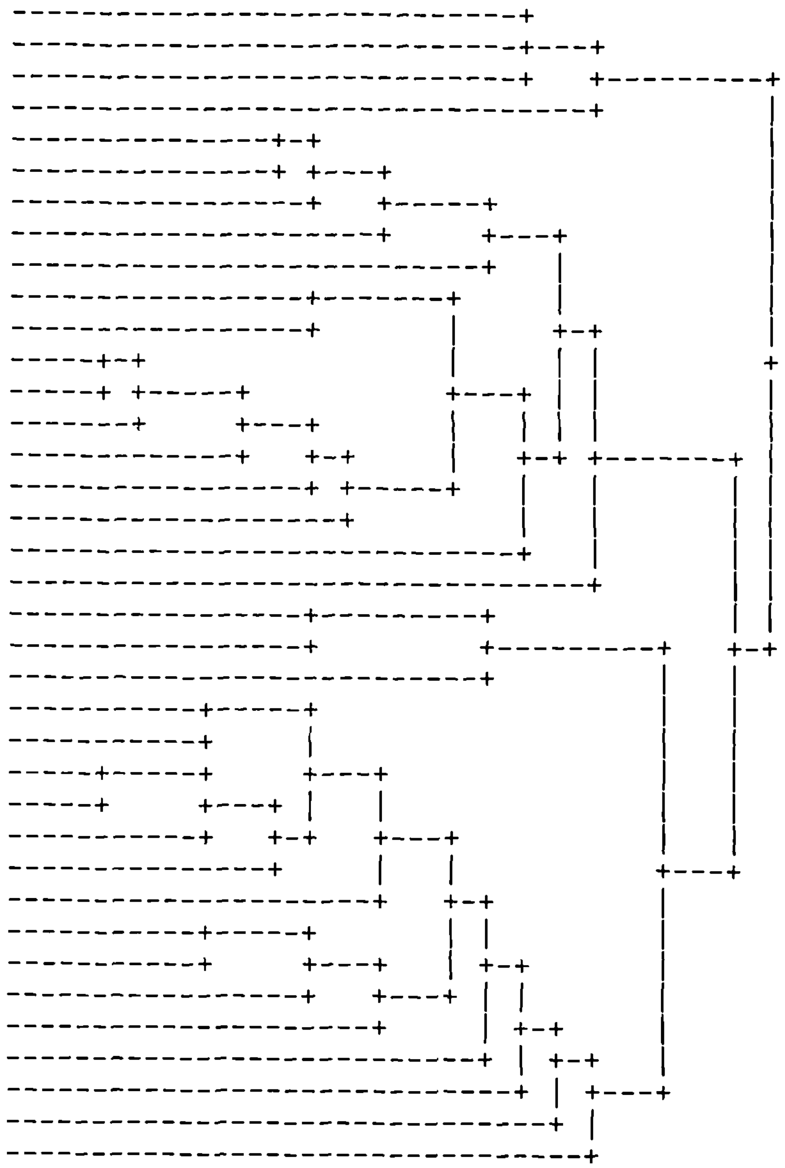
```
C40     38   -+-+
C84     75   -+ +-----+
C30     28   ---+     +---+
C32     30   ---------+   +-+
C118   103   -------------+ +-+
C65     58   ---------------+ +-+
C18     17   -----------------+ +---+
C117   102   -------------------+   |
C57     50   -+---------+           +-+
C63     56   -+         +---+       | |
C67     60   -----+-----+   +-+     | |
C109    96   -----+         | +-----+ +-+
C29     27   ---------------+ |       | |
C35     33   -----------------+       | |
C15     14   -----------+---+         | +-+
C123   108   -----------+   +---------+ | |
C26     24   ---------------+           | |
C44     41   -----------+---------+     | +---+
C55     49   -----------+         +-----+ |   |
C75     67   ---------------------+       |   +-+
C81     72   ---------------------------+-+   | +---+
C37     35   ---------------------------------+ |   |
C119   104   -----------------------------------+   |
C25     23   -----+-+                               |
C27     25   -----+ +-----+                         |
C8       7   -------+     +---+                     +-+
C28     26   -------------+   +---+                 | |
C4       3   -----------------+   +---+             | |
C41     39   ---------------------+   +-----+       | |
C116   101   -------------------------+     |       | |
C2       1   -----------------+-----+       +-------+ |
C121   106   -----------------+     +-+     |         |
C107    94   -----------------------+ +-----+         +
C78     69   -------------------------+               |
C16     15   -----------+---------+                   |
C80     71   -----------+         +-----+             |
C9       8   -----------+-------+ |     |             |
C14     13   -----------+       +-+     |             |
C10      9   -----------+---+   |       +---+         |
C36     34   -----------+   +---+       |   |         |
C22     20   ---------------+           |   +---------+
C59     52   -----------------------+---+   |
C62     55   -----------------------+       |
C99     89   -------------------------------+
```

Figure 6.2 : Clustering of the clients into four groups

(NB: Figure 6.2 continues on the next page, and is not drawn to scale)

Continuation of Figure 6.2

Group 2 (G2) : Consisting of 37 clients

C6	5	
C126	111	
C38	36	
C102	90	
C90	80	
C113	99	
C69	61	
C58	51	
C7	6	
C74	66	
C104	92	
C108	95	
C128	112	
C39	37	
C86	77	
C51	46	
C47	43	
C110	97	
C71	63	
C12	11	
C66	59	
C129	113	
C103	91	
C132	115	
C49	44	
C125	110	
C92	82	
C5	4	
C97	87	
C60	53	
C87	78	
C79	70	
C106	93	
C115	100	
C31	29	
C61	54	
C24	22	

(NB: Figure 6.2 continues on the next page)

Continuation of Figure 6.2

Group 3 (G3) : Consisting of 23 clients

```
C94      84  -----------------------+-----+
C96      86  -----------------------+     +-----+
C34      32  -----------------------------+     |
C83      74  -----------------------+-----+     +-----+
C89      79  -----------------------+     |     |     |
C76      68  -----------------+-+         +-----+     |
C130    114  -----------------+ +---+     |           |
C46      42  -------------------+   +-----+           |
C21      19  -----------------------+                 +
C13      12  -----------------------+-----------+     |
C112     98  -----------------------+           |     |
C64      57  -----------------+---------+       |     |
C93      83  -----------------+         |       |     |
C52      47  -----+-+                   +-----+ +-----+
C70      62  -----+ +-------+           |     | |
C50      45  -------+       +-----+     |     | |
C23      21  ---------------+     +-----+     | |
C98      88  ---------------------+           +-+
C82      73  -----------+---------+           |
C91      81  -----------+         +-+         |
C120    105  ---------------------+ +-----+   |
C19      18  -----------------------+     +---+
C85      76  -----------------------------+
```

Group 4 (G4) : Consisting of 11 clients

```
C33      31  -----------------------+---------+
C53      48  -----------------------+         |
C72      64  -----------------------+-----+   +-----+
C124    109  -----------------------+     |   |     |
C3        2  -----------------+---+       +---+     |
C11      10  -----------------+   +-----+ |         +
C95      85  ---------------------+     +-+         |
C17      16  -----------------------+---+           |
C42      40  -----------------------+               |
C73      65  -----------------------------------+---+
C122    107  -----------------------------------+
```

(End of Figure 6.2)

Table 6.2 : Specimen classification of cars

Type *(Main group)*	Brand *(Sub-group)*	Model *(Sub-sub-group)*	Sub-Attributes
Ford	Fiesta, Orion, Sierra, Escort, Mondeo, Granada, Scorpio, etc.	*Ghia*; Eclipse; Probe; Elegance; Popular(Plus); Laser; Sapphire; Bonus	16V; L; GL; SL; SR; LD; TD; LXi; I; Si;
Vauxhall	Cavalier, Astra, Vectra, Nova, Tigra, Frontera, Bellmont, Calibra; etc.	Merit; Ethos; Club; Luxe; Diamond	12V; 16V; LX; XRi; L; CD; GL; Si; LS; I;

6.3.6 Validity of the Cluster Analysis

Empirical classification was developed in the applied field of biological taxonomy without the rigours of tests of significance, probability modelling etc. (Hartigan, 1975). Hence, cluster analysis procedures have no inherent validity (Howard, 1991). By this disposition, diverse heuristic approaches have been used to judge the validity of classification. The extent of validity of a classification would thus depend on the yardstick used for assessing it.

If empirical classification has problems of validity and/or reliability, why use it? The answer to this, as it particularly concerned this research, is based on a perception by Williams and Lance (1965) that, depending on the intended purpose, a classification cannot be true or false, but profitable or unprofitable. The classification described beforehand is profitable for the following reasons:

1. It provides a theoretical basis for compartmentalising the sampled clients without the researcher having to do so arbitrarily.
2. It provides an opportunity for the patterns of clients' preferences to be studied, whether they are unique, communal, finite, exhaustive, etc.
3. It provides a basis for stratified sampling, which yields homogenous sub-groups which are intradepartmentally and individually alike. Thus group members provide more uniform data such that lower sample sizes could be acceptable when such sampling is used (Sanoff, 1977).

Due to these potential advantages, the classification of construction clients was undertaken. To ensure more valid results, the cluster analysis was performed several times using different proximity coefficients and algorithms. On each occasion the levels of homogeneity between the clustered clients were observed.

There are three criteria, which could be used for comparing the degree of homogeneity of grouped clients. These are (Kendall, 1970):

1. The rank correlation of the scores of the members of each group;
2. The coefficient of agreement of the clients' ratings of needs; and,
3. The proximity coefficient between members of each group.

To compute the amount of rank correlation between the members of each group, the ranking attached to needs by their members would be computed and arrayed in a matrix. Then a formula would be used to assess the extent to which all the rankings agree with each other (Kendall, 1970).

For the coefficient of agreement between the clients, one of Kendall's (1970) formulae could be used except that the actual preference ratings of the clients over the paired needs would be used instead of the rankings. The computation involved here is more demanding than the previous one.

The coefficient of association between members of each group involves a calculation of the proximity of the clients' preferences with respect to each other. The range and other descriptive measures of the proximity coefficients of the different groups are compared for extent of homogeneity. This method has been used by Chinyio et al., (1998a).

The three methods would produce concordant results in that they would each indicate a measure of the grouped clients' homogeneity (Kendall, 1970). Therefore any of them can be used in place of the other. Choice of one of these for the present analysis was made on the basis of availability of readily applicable computer software. In this regard, rank correlation coefficient (*W*) was readily available as one of the SPSS non-parametric programmes. Thus this coefficient was used in observing and comparing the homogeneity of the different client-groupings that were produced by the different approaches.

W (known as the coefficient of concordance) is given by the formula (Kendall, 1970):

$$W = \frac{12S}{m^2(n^3 - n)}, \text{ where:}$$

> S is the sum of squares of deviations between actual ratings and mean expected ratings;
> m is the number of judges (clients); and,
> n is the number of objects ranked.

W ranges from 0.00 to 1.00, where: 1.00 indicates perfect agreement in the ranking of needs, and, 0.00 absolute disagreement. If *W* approaches 1.00, the groupings represented would be highly homogenous, but if it tends towards 0.00 the groupings should not be considered as homogenous.

SPSS was used to calculate the *W*-coefficients of the emerging groups of clients. In this regard, data were extracted from Appendix C as the similarity of each group was assessed. Three cluster analyses outcomes were noted to have outperformed the others in terms of producing more compact sub-groups of clients. These trio, were all obtained by using the Block-City dissimilarity coefficient in conjunction with Mojena's stopping rule. The algorithms that performed well were the average-link; complete-link; and, Ward's method. The *W*-coefficients of their respective groupings are shown in Table 6.3.

Table 6.3 : Level of homogeneity of the classified clients - A comparative overview

Coefficient of concordance between the clients' rating of needs (*W*):						
Algorithm	Group 1	Group 2	Group 3	Group 4	Mean	S.D*
Average Link	0.4228	0.4973	0.4780	0.5228	**0.4800**	**.0400**
Complete Link	0.5156	0.3273	0.3231	N/A*	.3900	.1100
Ward's	0.5352	0.4647	0.2294	N/A	.4500	.1100

**N/A = Not applicable; and, S.D = Standard Deviation*

The average link algorithm produced 4 main groups of clients whilst the other two each produced 3 groups. Each major group produced by these algorithms seems to have its internal homogenous sub-groupings, as did the car groupings of Table 6.2. The composition of clients in the main groups identified varied with the different algorithms.

The coefficients of Table 6.3 suggest that the various groupings which the three algorithms represent, are at best moderately homogenous, an expected outcome as the clients were grouped at a macro-level. While each type of clustering produced a group whose coefficient of concordance was over 0.500, the complete-link and Ward's algorithms produced other groups that were weakly concordant. On the other hand, the average link algorithm produced groups that were relatively more consistent in being moderately concordant. Its relative superiority is reflected in the mean and standard deviation of its coefficients. It was on the basis of this performance that the outcome of the average link algorithm was adopted in the research.

6.4 Overview of the classification

The analysis presented in this chapter concerned the second main hypothesis, which sought to determine whether construction clients' needs-preferences were unique or somehow communal. The discussions in this chapter showed that empirical classification was developed without the rigours of test of significance, probability modelling etc. (Hartigan, 1975). Thus, the analysis could not be done in conformity with the norms of customary statistics.

In its exploratory nature the investigation sought to determine through cluster analysis whether clients' preferences were extremely unique or similar in some ways. The suggestion derived from the clustering was that homogenous sub-groups of clients were identifiable within those 115 clients that were studied. The procedure used could distinguish four major groups in the sample of clients. Therefore, the (second main) hypothesis concerning the uniqueness of construction clients' preferences should be rejected. Consequently the conclusion of chapter 10 subscribes that: construction clients cluster into needs-based groups.

6.5 Summary

This chapter set out to study the preferences of construction clients, to determine if clients' needs were similar or different. Empirical classification was reviewed as a guide to the analysis. By conducting a cluster analysis on the data available, four needs-based groups of clients were observed. The average link algorithm and Mojena's (1977) stopping rule were used in the cluster analysis. Since rigorous tests to validate the outcome were unavailable, comparative analyses were employed in a bid to obtain the best mix of clients in the homogenous sub-groupings.

Since the four groups identified in the cluster analysis are different, their values will be different. Part of the measurement reported in chapter 7, will evaluate the preferences of these clients in order to bring to light their value-differences. Based on the outcome of the cluster analysis in this chapter, some emerging groups of clients were sampled for further investigation which, pertained to the remaining two main hypotheses. The selection of these two sub-group(s) of clients for further study involved 'multi-stage sampling', as reported in chapter 4. It was in this regard that groups G1 and G2 were purposively sampled for further study.

CHAPTER 7

QUANTIFICATION OF NEEDS AND FACTORS INFLUENCING THEM

CHAPTER 7 : QUANTIFICATION OF NEEDS AND FACTORS INFLUENCING THEM

7.1 Introduction

This chapter concerns measurements, which were done using the data supplied by the two groups of clients that were sampled for this purpose. In this regard chapter 4 showed that G1 and G2 were purposively sampled for further study. The values of these two groups of clients and factors, which influenced their preferences, are evaluated. The measurements in this chapter enhanced the analyses in respect of the third and fourth main hypotheses.

Measurement is construed to mean "the process of taking data in their raw state and arranging them along some scale of comprehensible values" (Leedy, 1993). Two sets of measurements were made. The first, pertaining to the desire attached to needs by construction clients, was measured by the psychometric technique of paired comparisons. The other, concerning factors, which influenced clients' desires, was measured by descriptive statistics.

While completing the first questionnaire, the clients (members of G1 and G2) expressed simple preferences in respect of paired needs. The information they gave can be used to rank their individual needs. However, ranking falls short of identifying full values. If the needs of a client are to be used as constraints in the course of project decision making, then some form of measurement (scaling) to determine how much they are desired is necessary. It was in this respect that the needs of the selected clients were scaled to analyse for the differential information they would reveal. The paired-comparisons technique chosen for the scaling is explained prior to its application because, it has been rarely applied in construction literature.

7.2 Thurstone's principle of Paired Comparisons

Thurstone (1927) presented an analogy, which can relate the scale values of a set of stimuli with their corresponding observable proportions. The scale values represent the intensities of given stimuli on a psychological continuum. According to Thurstone's analogy, stimuli when presented to observers give rise to respective discriminal processes. In effect, when a stimulus is activated through either a chance or deliberate encounter, it excites a sensation (desire, joy, sadness, etc.) in the mind of the individual who is encountering it. The intensity of this sensation can be mapped on a scale (continuum).

The amount of sensation generated by any one stimulus varies with the occasion, thus varying its location on the continuum. An inference from descriptive statistics indicates that if a stimulus is activated many times, the scale value of that stimulus will be the 'mode' pertaining to the frequency of occurrence of that stimulus (modal discriminal process). The multiple sensations of any one stimulus are assumed to be normally distributed, and, in normal distributions, the mean, median and mode coincide. Therefore, in addition to the modal discriminal process, either the mean or median values of a set of discriminal processes can be used to scale the value of a sensation that has been generated by a stimulus.

Where qualitative assessments are involved, an observer cannot easily ascertain the discriminal process (amount of sensation) pertaining to an encountered stimulus. Therein comes the logic of paired comparisons. These sensations are indirectly ascertained by a series of comparative judgements. For a pair of stimuli, say x and y, the discriminal difference of their sensations would be:

$(d_x - d_y)$, where:

d_x and d_y are discriminal processes associated with stimuli x and y, respectively.

Although some people may find it hard to decipher the exact amount of desire they attach to different stimuli, they can easily indicate their relative preference(s) for two or more stimuli. That is, while d_x and d_y may both be unknown, their difference $(d_x - d_y)$

can be assessed as positive or negative. Since d_X and d_y do vary in intensity, depending on when they are encountered, it follows that if $(d_X - d_y)$ is generated several times, one of its two arithmetical values (positive/negative), would outweigh the other.

Statistics informs us that the difference between the means of two normal distributions is equal to the mean of their differences (Baird and Noma, 1978). Thus, if several discriminal differences (i.e., $|d_X - d_y|$'s) are generated for the same pair of stimuli, they will form a normal distribution with a mean that is equal to the difference in scale values between stimulus x and y (i.e., $\mu_x - \mu_y$). So the difference in the values of two stimuli can indirectly be found from the mean of the distribution of their discriminal differences.

Derivations from the standard deviation formula infer that (Torgerson, 1958):

$$\delta_{d_X - d_y} = (\delta_y^2 + \delta_x^2 - 2r_{yx}\,\delta_y\,\delta_x)^{1/2},$$

Where: r_{yx} is momentary correlation between d_y and d_X.

From multiple pair-comparisons, $S_X - S_y$ ($= \mu_x - \mu_y$), which is the difference in the intensities of two stimuli, can be ascertained in terms of $\{\delta_{d_X - d_y}\}$ units by the equation:

$$S_X - S_y = X_{yx}\,\delta_{d_X - d_y}$$

$$= X_{yx}\,(\delta_y^2 + \delta_x^2 - 2r_{yx}\delta_y\delta_x)^{1/2} \text{ ---------- (1); where:}$$

S_X ,S_y are scale values of stimuli x and y respectively;

δ_x,δ_y are discriminal dispersions of stimuli x and y respectively;

r_{yx} is correlation between pairs of discriminal processes d_y and d_X; and

X_{yx} is normal deviate corresponding to proportion of times stimulus x is preferred over stimulus y.

Equation (1) is Thurstone's full analogy of the law of comparative judgement. It has been simplified into several variants based on differing assumptions. The simplifications were made because the full law could not be solved due to a greater number of unknowns in the equation. Thus the full law was reduced to the form:

$$S_x - S_y = X_{yx}\,(Q), \text{ ------------------------------------ } (2)$$

Where: Q is a varying expression that depends on the particular assumption being made.

By making several assumptions, Thurstone (1927) proffered five different variants of the law (Cases I to V). Thurstone's 'Case-V' is the simplest of his variants, and, is most often adopted for scaling (Baird and Noma, 1978). This variant was thus adopted for scaling in the current research.

7.2.1 Axioms of the law

In Case-V of Thurstone's law, the two assumptions are that (Allen and Yen, 1979):

1. the discriminal dispersions of sensations corresponding to stimuli are equal; and,
2. correlations between pairs of stimuli sensations are zero.

By these assumptions, Q in equation (2) then becomes (Thurstone, 1927):

$$Q = (2\delta_y \delta_x^2)^{1/2} \text{ ------------------- } (3)$$

Further, by assuming ($\delta_y\delta_x$) to be the unit of measurement, Thurstone reduced equation (3) to:

$$S_x - S_y = 1.4142\, X_{yx}$$

Mosteller (1951a) then showed that by relaxing the zero correlation assumption, the approach leads to a least-squares solution. Applications of the paired-comparisons technique have often used the least-squares approach.

7.2.2 Process of determining stimuli intensities using Thurstone's law

Scale values of stimuli are practically computed via a series of matrices (Dunn-Rankin, 1983). The first two matrices show two different forms of the proportion of times each stimulus was desired over its counterparts. The next computation relates to the normal table. Normal deviates of the proportions are obtained through extractions from the normal table. Adjacent column entries of the normal deviates are then subtracted and averaged out. By least squares computations the quantity of each stimulus is established.

In order to effect a scaling, several discriminal differences (between paired stimuli) have to be generated. Such multiple discriminal differences can be generated either by asking one person to make several choices on the same set of paired stimuli, or, several (homogenous) persons could each make one set of judgement on the paired stimuli (Kendall, 1955; David, 1969).

Given that G1 and G2 were classified in chapter 6 and sampled as being members of homogenous needs-based groups, information from the 38 clients of G1 were used as repetitive choices for scaling the needs of G1. This was done as if G1 were an individual making $m = 38$ sets of preference choices. Likewise the 37 repetitive choices of G2 were used to scale the desires of G2 in respect of the eight generic needs adopted in the research.

Where a set of n stimuli are involved in paired comparisons, the complete number of their pairs would be (Kendall and Babington-Smith, 1939):

$$\binom{n}{2} = \frac{n(n-1)}{2}.$$

For m number of judges, the total number of judgements expected from them on the paired stimuli would thus be: $m\binom{n}{2}$.

7.2.3 Characteristics of scaled data

The values of the stimuli so scaled would have interval properties. However these scale values (would) have both an arbitrary origin and unit of measurement (Coombs et al., 1970). Computations for establishing the absolute origin of a pair-comparison scale are available (Guildford, 1954). If the origin of the scale were to be established relative to the scaled values, the scale would have the properties of a ratio scale.

However, the computations leading to the establishment of the origin of a pair-comparison scale are mathematically complicated. The benefit of using a ratio scale over an interval one would have to outweigh the gravity of employing the computations to justify their use. In this research, the extra effort of establishing the origin of the scale values was not sought on the basis that data on an interval scale were sufficient for the considerations of the research.

7.2.4 Advantages of Thurstonian scaling

The following five advantages of psychometric scaling have been discussed by Nunnally (1978):

1. Objectivity - individuals often disagree in their subjective quantification of stimuli, thus an objective score (obtained by psychometric scaling) would help remove ambiguity and inconsistency in the assessment of stimuli.
2. Finer details - scaling warrants segregation of attributes at the level of finer details. It transforms an ordinal set of data unto an interval scale. This gives more insight. Additional information provided by the transformation of data from an ordinal to interval scale could lead to more insight into the patterns of clients' desires and hence provide a better basis for more rigorous decision analysis.
3. It enhances the use of more powerful mathematical analyses with the resulting data.
4. It enhances a standardisation that goes towards more effective communication concerning the subject matter.
5. It introduces economy and saves time in subsequent evaluations as against the use of subjective or first-principle measurements.

7.2.5 Disadvantages of Thurstonian scaling

The following are some expressed setbacks with Thurstonian scaling:

1. Soliciting multiple comparative judgements from interviewees can be tiring or cumbersome to them. The number of pairs of stimuli to be compared increases geometrically with increasing number of stimuli, hence, studies employing this method are usually limited to 10-15 stimuli (Gulliksen and Tucker, 1961).

2. Without the help of computer facilities the analyses leading to the establishment of scale values are demanding.

3. Scale values generated are forced to lie on a unidimensional continuum (Baird and Noma, 1978). There is thus no definite account of conflicting objectives, which might lie in different dimensions.

7.2.6 Applicability of paired comparisons in construction practice

Fawcett (1998) used the method of paired-comparisons in measuring the preferences of some users of building products and construction industry personnel who included architects, planning consultants, estate agents, developers and investors. Fawcett dwelled on the differential desires attached to six selected design options of a type of office block. The building options varied in different combinations of roof shape, walling material and architectural character. He discovered major differences, in terms of preferences, between the two groups surveyed (i.e., users and industry personnel).

Although Fawcett applied the paired comparison technique as a measuring tool in his research, he did not use it to evaluate clients' needs as they are defined in the present research. However, his successful application of this technique in a construction scenario provided a hope that construction clients may not be highly unhappy with the intricacies of the tool. Fawcett also illustrated that computer usage can minimise the effect of the setbacks outlined in section 7.2.5, and, render the measurement process user-friendly.

7.3 Scaling the preferences of G1 and G2 by paired comparisons

The scaling of this research was done in line with precedent illustrations, especially those of Guildford (1954), Sanoff (1977), Dunn-Rankin (1983) and Chinyio et al., (1998b). The first step in the scaling process was to collate the clients' (G1 and G2) responses by tabulating the number of times each need was preferred over the others. To do this, the clients' preferences as expressed in their questionnaires were scored. Following a recommendation, (Kendall, 1955), each 'preference' rating of a need was scored by 1, 'no-preference' by 0 and 'an indifference' by ½. The maximum cumulative preference score of a need by one client in the research could not exceed 7, which is the number of times any one need was compared with the others.

The collation of preference scores for the two clients (G1&G2) are shown in Tables 7.1 & 7.2. The entries in the Tables are interpreted as: number of times a column attribute was preferred over a row attribute. For instance, the bold-faced value of 25 in Table 7.1 indicates that for G1, economy was preferred over (lack of) surprises 25 times. No need was compared with itself hence the cells in the north-west to south-east diagonals are empty in the two Tables.

The next task was to re-arrange the columns of Tables 7.1/7.2 so that the stimuli were ordered in a lexicographical manner (Tables 7.3/7.4). The reason for ordering the stimuli this way would be made apparent later. After the re-arrangements the next computation involved converting the preference-scores into proportions which, were computed by the formula:

$$P_{ij} = \frac{F_{ij}}{N}, \text{ where:}$$

P_{ij} is proportion;

F_{ij} is frequency score (as obtained from Tables 7.3 & 7.4); and,

N is the number of times comparative judgements were made (i.e., 38 for G1 and 37 for G2).

The computed proportions are shown in Tables 7.5/7.6.

Extreme proportions tend to distort the results, and so it has been recommended by Dunn-Rankin (1983) that proportions in excess of 0.98 be reduced to this figure. Likewise, those proportions that are less than 0.02 should be raised to this figure. Dunn-Rankin's opinion is based on the understanding that probabilities less than 0.02 or greater than 0.98 occupy extreme and unstable positions in the normal probability density graph.

The adjustments recommended by Dunn-Rankin are shown in Table 7.6 where extreme values were encountered. In both Tables 7.5/7.6 the value of 0.50 was entered in the cells of the hitherto blank diagonals. This was based on the norm that if an attribute was compared with itself several times, each half will be selected half the number of times (Kendall, 1955).

Having obtained the foregoing proportions, the next step in the computation process was to obtain normal deviates of these proportions from statistical tables. Tables 7.7/7.8 show the extracted values which were obtained using Rohlf and Sokal's (1969) Statistical Tables. Tables 7.1 to 7.8 should be symmetric about the 'north-west to south-east' diagonal. However, since some intransitive preferences in the information supplied by some clients were accepted without rectifying the anomalies, the values in these Tables are not perfectly symmetrical.

Going by the least-squares approach, quantities in the cells of Tables 7.7/7.8 were subtracted from each other (i.e. between neighbouring columns) and averaged out. These two aspects of the computation are shown in Tables 7.9/7.10. From the averaged values in these Tables, the desires of G1&G2 were quantified, as shown in Tables 7.11/7.12 which, complete the scaling procedure. In Tables 7.9/7.10, values in the rows designated as 'least squares solution' indicate relative intensities with which the eight needs were desired by G1/G2 (i.e., respective $[\mu_{i+1} - \mu_i]$'s).

Having established these differences, one stimulus is chosen as an anchor whereby its value is arbitrarily fixed as a constant and the values of the other stimuli were determined relative to it (Allen and Yen, 1979). The least desired needs were accordingly anchored at a chosen value of 0.00 and the scores of the other needs were derived relative to this anchor. The resulting scale values (see Tables 7.11/7.12) reflect the relative desires of G1/G2. It is the determination of relative preference values by successive subtractions that necessitated the re-ordering of stimuli between Tables 7.1/7.2 and 7.3/7.4.

Table 7.1 : Frequencies by which G1 preferred one need over the others

Stimuli	Aesthetics	Economy	Function	Quality	Relations	Safety	Surprises	Time
Aesthetics	-	14.5	26.5	33	9	34	9	5.5
Economy	22.5	-	31	29	6	32.5	12	11.5
Function	10.5	6	-	21	6.5	33.5	9	8
Quality	4	7	16	-	1	27	3	4.5
Relations	27	31	30.5	36	-	29	20	22
Safety	3	3.5	3.5	10	8	-	5	4
Surprises	28	**25**	28	34	17	31	-	15
Time	31.5	25.5	29	32.5	15	32	22	-
Total:	126.5	112.5	164.5	195.5	62.5	219	80	70.5
(Rank of total)	*4*	*5*	*3*	*2*	*8*	*1*	*6*	*7*

Table 7.2 : Frequencies with which G2 preferred one need over the others

Stimuli	Aesthetics	Economy	Function	Quality	Relations	Safety	Surprises	Time
Aesthetics	-	31	35.5	34	24	32.5	36	33
Economy	6	-	19.5	25	6	17	16.5	12
Function	1.5	17.5	-	22	3.5	19	17.5	8
Quality	3	12	15	-	0.5	15	12	7
Relations	13	32	32.5	36.5	-	26	29	28.5
Safety	4.5	20	18	22	11	-	10.5	13
Surprises	1	20.5	19.5	25	7	26.5	-	16
Time	3	25	29	30	8.5	24	21	-
Total:	32	158	169	194.5	60.5	160	142.5	117.5
Rank	*8*	*4*	*2*	*1*	*7*	*3*	*5*	*6*

Table 7.3 : Lexicographic ordering of the frequencies with which G1 preferred one need over the others

Stimuli	Relations	Time	Surprises	Economy	Aesthetics	Function	Quality	Safety
Relations	-	22	20	31	27	30.5	36	29
Time	15	-	22	25.5	31.5	29	32.5	32
Surprises	17	15	-	25	28	28	34	31
Economy	6	11.5	12	-	22.5	31	29	32.5
Aesthetics	9	5.5	9	14.5	-	26.5	33	34
Function	6.5	8	9	6	10.5	-	21	33.5
Quality	1	4.5	3	7	4	16	-	27
Safety	8	4	5	3.5	3	3.5	10	-
Total:	62.5	70.5	80	112.5	126.5	164.5	195.5	219
Rank order	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*

Table 7.4 : Lexicographic ordering of the frequencies with which G2 preferred one need over the others

Stimuli	Aesthetics	Relations	Time	Surprises	Economy	Safety	Function	Quality
Aesthetics	-	24	33	36	31	32.5	35.5	34
Relations	13	-	28.5	29	32	26	32.5	36.5
Time	3	8.5	-	21	25	24	29	30
Surprises	1	7	16	-	20.5	26.5	19.5	25
Economy	6	6	12	16.5	-	17	19.5	25
Safety	4.5	11	13	10.5	20	-	18	22
Function	1.5	3.5	8	17.5	17.5	19	-	22
Quality	3	0.5	7	12	12	15	15	-
Total:	32	60.5	117.5	142.5	158	160	169	194.5
	8	*7*	*6*	*5*	*4*	*3*	*2*	*1*

Table 7.5 : G1's relative preferences of needs, expressed as Proportions

Stimuli	Relations	Time	Surprises	Economy	Aesthetics	Function	Quality	Safety
Relations	0.50	0.58	0.53	0.82	0.71	0.80	0.95	0.76
Time	0.39	0.50	0.58	0.67	0.83	0.76	0.86	0.84
Surprises	0.45	0.39	0.50	0.66	0.74	0.74	0.89	0.82
Economy	0.16	0.30	0.32	0.50	0.59	0.82	0.76	0.86
Aesthetics	0.24	0.14	0.24	0.38	0.50	0.70	0.87	0.89
Function	0.17	0.21	0.24	0.16	0.28	0.50	0.55	0.88
Quality	0.03	0.12	0.08	0.18	0.12	0.42	0.50	0.71
Safety	0.21	0.11	0.13	0.09	0.08	0.09	0.26	0.50

Table 7.6 : G2's relative preferences of needs expressed as Proportions

Stimuli	Aesthetics	Relations	Time	Surprises	Economy	Safety	Function	Quality
Aesthetics	0.50	0.65	0.89	0.97	0.84	0.88	0.96	0.92
Relations	0.35	0.50	0.77	0.78	0.86	0.70	0.88	0.99 (= 0.98)*
Time	0.08	0.23	0.50	0.57	0.68	0.65	0.78	0.79
Surprises	0.03	0.19	0.43	0.50	0.55	0.72	0.53	0.68
Economy	0.16	0.16	0.32	0.45	0.50	0.46	0.53	0.68
Safety	0.12	0.30	0.35	0.28	0.54	0.50	0.49	0.59
Function	0.04	0.09	0.22	0.47	0.47	0.51	0.50	0.59
Quality	0.08	0.01 (= 0.02)*	0.19	0.32	0.32	0.41	0.41	0.50

Table 7.7 : Normal deviates of G1's proportional preferences of needs

Stimuli	Relations	Time	Surprises	Economy	Aesthetics	Function	Quality	Safety
Relations	0.00	0.21	0.08	0.92	0.55	0.84	1.65	0.71
Time	-0.28	0.00	0.21	0.44	0.95	0.71	1.08	0.99
Surprises	-0.12	-0.28	0.00	0.41	0.64	0.64	1.23	0.92
Economy	-0.99	-0.53	-0.47	0.00	0.23	0.92	0.71	1.08
Aesthetics	-0.71	-1.08	-0.71	-0.31	0.00	0.52	1.13	1.23
Function	-0.96	-0.81	-0.71	-1.00	-0.58	0.00	0.13	1.18
Quality	-1.88	-1.18	-1.41	-0.92	-1.18	-0.20	0.00	0.55
Safety	-0.81	-1.23	-1.13	-1.34	-1.41	-1.34	-0.64	0.00

Table 7.8 : Normal deviates of G2's proportional preferences of needs

Stimuli	Aesthetics	Relations	Time	Surprises	Economy	Safety	Function	Quality
Aesthetics	0.00	0.39	1.23	1.88	0.99	1.18	1.75	1.41
Relations	-0.39	0.00	0.74	0.77	1.08	0.52	1.17	2.05
Time	-1.41	-0.74	0.00	0.18	0.47	0.39	0.77	0.81
Surprises	-1.88	-0.88	-0.18	0.00	0.13	0.58	0.08	0.47
Economy	-0.99	-0.99	-0.47	-0.13	0.00	-0.10	0.08	0.47
Safety	-1.17	-0.52	-0.39	-0.58	0.10	0.00	-0.03	0.23
Function	-1.75	-1.34	-0.77	-0.33	-0.33	0.03	0.00	0.23
Quality	-1.41	-2.05	-0.88	-0.47	-0.47	-0.23	-0.23	0.00

Table 7.9 : Proportionate differences between stimuli as desired by G1

Column arithmetic	2-1	3-2	4-3	5-4	6-5	7-6	8-7
Statements	Tim - Rel	Sur - Tim	Eco - Sur	Aes - Eco	Fun - Aes	Qua - Fun	Saf - Qua
	0.21	-0.13	0.84	-0.37	0.29	0.81	-0.94
	0.28	0.21	0.23	0.51	-0.24	0.37	-0.09
	-0.16	0.28	0.41	0.23	0.00	0.59	-0.31
	0.46	0.06	0.47	0.23	0.69	-0.21	0.37
	-0.37	0.37	0.40	0.31	0.52	0.61	0.10
	0.15	0.10	-0.29	0.42	0.58	0.13	1.05
	0.70	-0.23	0.49	-0.26	0.98	0.20	0.55
	-0.42	0.10	-0.21	-0.07	0.07	0.70	0.64
Sum	0.85	0.76	2.34	1.00	2.89	3.20	1.37
n	8	8	8	8	8	8	8
Least squares solution (= Sum/n)	0.11	0.10	0.29	0.13	0.36	0.40	0.17

NB: ' n' is the number of stimuli which is 8. Stimuli are abbreviated as ***Aesthetics*** *,* ***Economy****,* ***Functionality****,* ***Quality****,* ***Relations****,* ***Safety****,* ***Surprises*** *and* ***Time****.*

Table 7.10 : Proportionate differences between stimuli as desired by G2

Column arithmetic	2-1	3-2	4-3	5-4	6-5	7-6	8-7
Statements	Rel - Aes	Tim - Rel	Sur - Tim	Eco - Sur	Saf - Eco	Fun - Saf	Qua - Fun
	-0.64	1.21	0.33	0.00	0.24	0.00	0.23
	0.41	0.57	0.44	0.00	0.30	-0.03	0.22
	0.65	0.13	-0.19	0.68	-0.10	-0.03	0.26
	0.00	0.52	0.34	0.13	-0.10	0.18	0.39
	1.00	0.70	0.18	0.13	0.45	-0.50	0.39
	0.67	0.74	0.18	0.29	-0.08	0.38	0.04
	0.39	0.74	0.03	0.31	-0.56	0.65	0.89
	0.39	0.84	0.65	-0.89	0.19	0.57	-0.34
Sum	2.87	5.45	1.96	0.65	0.34	1.22	2.08
n	8	8	8	8	8	8	8
Least squares solution	0.36	0.68	0.25	0.08	0.04	0.15	0.26

The scaled desires established have interval properties by which linear transformations were, performed on them. These transformations were of the nature (Allen and Yen, 1979): $y = (ax + b)$, where:

y is transformed value;

x is originally scaled value; and,

a,b are constants.

Any linear transformation of scale values preserves their positions relative to one another. The transformed scale values were also standardised (on a scale of 1 to 100) so that the most desired need assumed a value of 100 and the least desired need a value of 5. This was done by substituting into the above equation: a = 60.9; and, b = 5 (for G1); and, a = 52.2; and, b = 5 (for G2). The resulting standardised values of the scaled needs for both Gl and G2 are reflected in the third columns of Tables 7.11/7.12 where the values have been rounded up to the nearest whole number.

Table 7.11 : Scale values of Gl's needs-desires

Stimulus	Computation of scale values	Standardised value	Rank
Relations	0.00*	5	8
Time	(0.00 + 0.11) = 0.11	12	7
Surprises	(0.11 + 0.10) = 0.21	18	6
Economy	(0.21 + 0.29) = 0.50	35	5
Aesthetics	(0.50 + 0.13) = 0.63	43	4
Function	().63 + 0.36) = 0.99	65	3
Quality	(0.99 + 0.40) = 1.39	90	2
Safety	(1.39 + 0.17) = 1.56	100	1

**NB: The least desired stimulus was anchored at a value of 0.00*

Table 7.12 : Scale values of G2's needs-desires

Stimulus	Computation of scale values	Standardised value	Rank
Aesthetics	0.00	5	8
Relations	(0.00 + 0.36) = 0.36	24	7
Time	(0.36 + 0.68) = 1.04	59	6
Surprises	(1.04 + 0.25) = 1.29	72	5
Economy	(1.29 + 0.08) = 1.37	77	4
Safety	(1.37 + 0.04) = 1.41	79	3
Function	(1.41 + 0.15) = 1.56	86	2
Quality	(1.56 + 0.26) = 1.82	100	1

The outcome of this scaling denotes the relative desires of G1 and G2. Figure 7.1 shows a juxta-positioning of the desires of the two clients. In line with the two objectives of Section 7.1, the next task was to scale the impact with which the attributes in the second questionnaire influenced the respective desires of the clients.

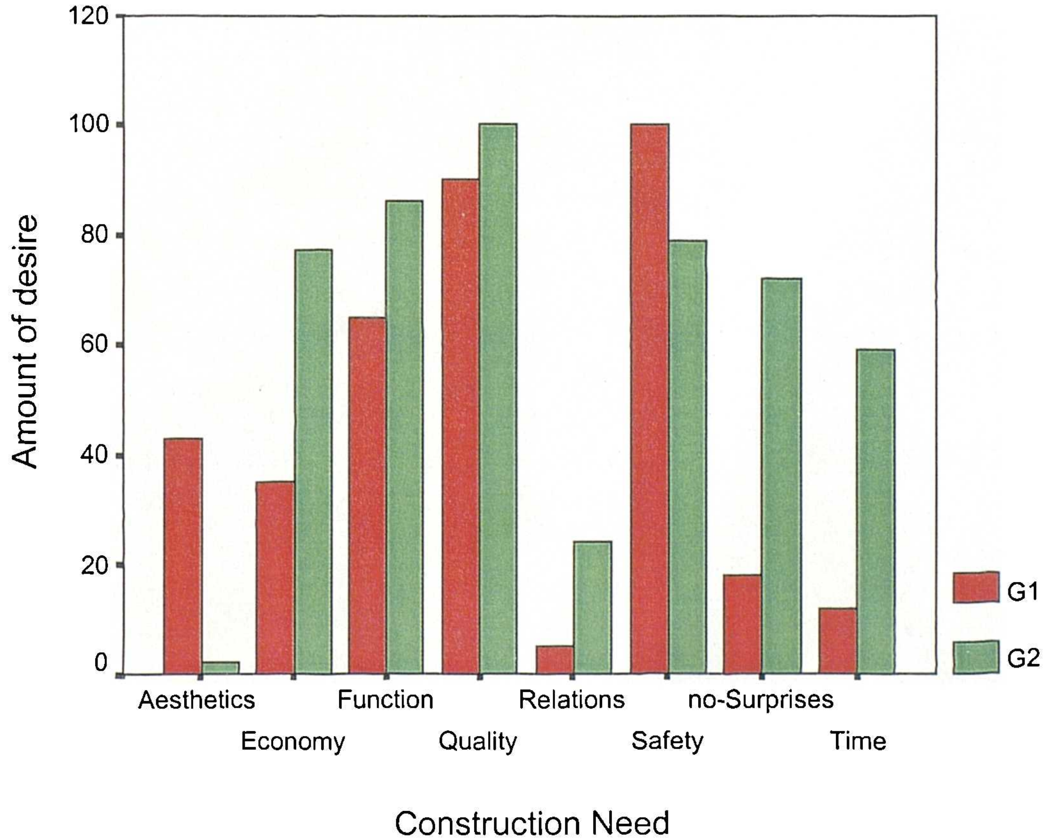


Figure 7.1 Differential values attached to construction needs by G1 and G2

7.4 Extent by which 23 attributes influenced the desires of G1 and G2

The scoring of attributes by the clients was quantified using descriptive statistics. The rating of attributes by the clients through the second questionnaire, were compiled where the outcome is given in Appendix J (for members of G1) and Appendix K (for members of G2). The individual scores of the participating clients were aggregated using SPSS. The summary of the results is shown in the representation of Table 7.13 and Figure 7.2.

The sample sizes on which the data of Table 7.13 were derived varied because some clients did not score some attributes. The mean-values in Table 7.13 should be interpreted along with their corresponding standard deviations as their information were aggregated from several clients. This scaling of the information from the second questionnaire completed the task of measurement as outlined in Section 7.1.

Figures 7.1 and 7.2 show aspects of similarities and differences between G1 and G2. Statistical tools were employed to assess the differences between G1 and G2 in terms of their desires, and factors, which influenced them. These assessments are the subject of chapter 8.

Table 7.13 : A compilation of attributes influencing clients' desires of needs

Attribute:	G1 Mean	G1 S.D*	N_1	G2 Mean	G2 S.D	N_2
1) Organisational identity	21.79	26.67	28	38.75	34.81	24
2) Business function	47.86	36.95	28	55.83	32.43	24
3) Size of organisation	25.17	32.69	29	22.08	22.84	24
4) Number of employees	12.41	19.58	29	16.25	17.15	24
5) Status of employees	8.97	18.39	29	13.33	18.57	24
6) Type of facility built	78.97	19.70	29	43.33	29.73	24
7) Type of development: new or refurbishment	60.34	28.47	29	37.50	23.27	24
8) Size of building(s) and/or rooms	50.00	32.29	29	50.00	26.87	24
9) Type of clients/customers	70.69	24.77	29	66.67	24.79	24
10) Expressed desires of clients or customers	61.38	30.56	29	61.82	23.63	22
11) Public opinion concerning building product/materials	37.93	29.32	29	31.82	25.94	22
12) Public perception of your organisation	39.31	31.37	29	45.00	25.02	24
13) Needs of other users of the facility	55.00	26.46	28	60.83	25.01	24
14) Special users' (e.g. disabled, etc.) needs	68.62	23.86	29	69.17	19.09	24
15) Specifications of consultants	48.28	31.06	29	36.09	25.18	23
16) Advise of in-house professionals	61.07	26.57	28	37.83	27.95	23
17) Planning regulations	68.62	23.86	29	63.33	21.80	24

Collation of Scores:

Table 7.13 continues on the next page

A compilation of attributes influencing clients' desires of needs : A continuation of Table 7.13

	Collation of Scores:					
Attribute:		G1			G2	
	Mean	S.D*	N_1	Mean	S.D	N_2
18) Building regulations	65.17	28.11	29	53.33	25.48	24
19) Competition with rivals	19.29	22.76	28	37.50	32.34	24
20) Personal taste of company owners or directors	20.69	25.06	29	12.08	12.50	24
21) Personal taste of a designated project officer	21.72	22.69	29	13.33	14.35	24
22) Aggregated taste of management staff	24.48	23.99	29	19.17	14.12	24
23) Aggregated taste of company employees	15.36	19.72	28	10.00	11.42	24

*NB: *S.D = Standard deviation*

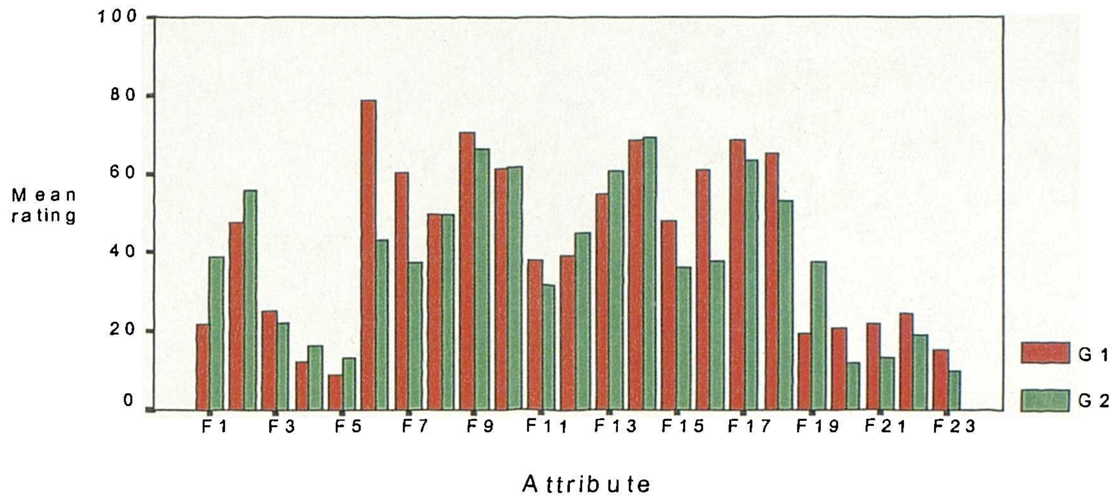


Figure 7.2 : Level of influence of some attributes on clients' needs

7.5 Summary

This chapter concerned the measurement of the values of two clients (G1 and G2) in terms of their project requirements, and, how much some 23 attributes influenced their respective desires. The preferences of the clients were scaled using the psychometric technique of paired-comparisons while the impact of the aforementioned attributes was measured by descriptive statistics. Figures 7.1 and 7.2 showed how the features of the two clients varied, with the preferences being more variable than the impact of attributes.

The measurements in this chapter enhanced the analyses in chapter 8, which concerned the third and fourth main hypotheses of the study. Prior to expressing their preferences, the clients defined these needs in section-B of the first questionnaire. These definitions are discussed along with the other analyses of chapter 8.

CHAPTER 8

AN ANALYSIS OF THE NEEDS - PREFERENCES OF TWO GROUPS OF CONSTRUCTION CLIENTS

CHAPTER 8 : AN ANALYSIS OF THE NEEDS-PREFERENCES OF TWO GROUPS OF CONSTRUCTION CLIENTS

8.1 Introduction

This chapter reports on the analyses concerning the third and fourth hypotheses of the research, namely:

- *third hypothesis* - 'the project requirements of construction clients are the same'; and,
- *fourth hypothesis* - 'no predominant factors underpin construction clients' needs'.

Chapters 1 and 4 had specified that comparative analyses were performed. In this respect, testing for differences of means, proportions, etc. were employed. Given that a quantitative survey was selected for the research and that quantitative data were generated in Chapter 7, it was appropriate to employ statistical techniques for the analyses wherein the needs-desires of two clients (G1 and G2) and factors underpinning them were compared and contrasted.

The following issues are covered in the analyses:

- the definition of needs by the clients;
- the differential magnitudes of desire attached to needs;
- the pattern of the preferences of construction clients, concerning needs;
- the predominant attributes underpinning clients' needs-desires;
- the differences in the rating of predominant attributes by the clients; and,
- the predominant factors influencing the needs of the clients.

8.2 Definition of needs by the clients

Different clients may construe 'needs' differently. For example, one client may use the phrase 'aesthetics' to mean the colour of interior walls, while, another client may by the same phrase be referring to how a building fits into its environment. Thus the present analysis observed and compared how two clients defined needs on different occasions.

To harmonise the analysis, the clients were given a checklist and asked to indicate the attributes that were relevant to their respective projects. In this regard G1 and G2 consisting of 38 and 37 clients respectively, were in chapter 6 construed as representing two individual persons with each of them responding to the same questionnaire 38/37 times accordingly.

Each member of G1 and G2 defined his/her/their project needs and described the project upon which the definition was based. Thus, 38 sets of definitions of needs were obtained from G1, and, 37 from G2. Cumulatively the patterns of the definitions of the needs were observed over the 38 and 37 projects reported upon by the two respective clients. The observation was made in order to identify differences with which G1 and G2 perceived their project requirements. If these two, and inferentially other clients, attached different meanings to needs, it is equally likely that construction producers could perceive clients' needs differently from the way the clients do understand them to be. If so, the exact meaning of a particular need could be misconstrued when its definition is being extracted from clients.

The analysis therefore compared and contrasted the frequencies with which different meanings of needs were applicable to G1 and G2 in their project schemes. This was done using the answers reflected by the clients in Section-B of the first questionnaire. In this regard responses made by clients belonging to G1 and G2 were collated in order to assess whether the two of them displayed similar/different likeness for the different features of the eight main needs that were presented to them.

8.2.1 Difference(s) between G1 and G2 in their definition of aesthetics

The proportion of times the different attributes of aesthetics were identified by G1 and G2 are shown in Table 8.1. The scoring of meanings by G1 and G2 could be tested for statistical similarity or dissimilarity, by using either the "chi-square independence test" (Everitt, 1977); or, test for "differences of proportions" (Weiss, 1995). The chi-square test is appropriate where two or more attributes are to be tested collectively while the test for differences in proportions is preferable when the attributes are to be compared one at a time.

Since the research had grouped several subsets of attributes under eight main needs, the chi-square test was initially used to test for differences between G1 and G2 on each of these main needs. Where significant differences were observed at this level, the test for differences of proportions was then used to detect those attributes that had contributed to the statistical difference in the distribution of the scores of the two clients.

Table 8.1 : Frequencies with which the attributes of aesthetics were desired by G1 and G2

	Attributes voted for:	**Frequency G1**	**Frequency G2**
A1	Beautiful looking product	27	23
A2	Beautiful interior	19	10
A3	Beautiful exterior	26	12
A4	Beautiful finishes/decorations	17	9
A5	*Building to fit-in and balance with the surroundings*	*7*	*4*
A6	*Building to have the appropriate "feel"*	*1*	*1*
A7	*Building to be user friendly*	*1*	*0*
A8	*Building appearance to comply with planning permission*	*0*	*1*

NB: Attributes shown in italics (A5 to A8) were specified by the clients while completing their questionnaires.

To test if the proportions of scores returned by G1, in Table 8.1, were relatively different from those of G2, a set of hypothesis was developed. The null and alternative hypotheses were defined as:

H_{01} : The distribution of votes of the meanings of aesthetics is independent of G1 and G2; and,

H_{A1} : The distribution of votes of the meanings of aesthetics is dependent on G1 and G2.

To proceed with the chi-square test, expected frequencies of the respective client-scores were computed. These expected frequencies are italicised in Table 8.2 where, each expected frequency was obtained from the formula: $r.c/n$, where:

r is row total;

c is column total; and,

n is overall total.

The axioms underpinning the chi-square independence test are (Weiss, 1995):

1. Each expected frequency should at least be 1; and,
2. At most, 20% of the expected frequencies should be less than 5.

Table 8.2 shows how some expected frequencies did not satisfy these conditions.

Table 8.2 : Actual and expected frequencies by which the meanings of aesthetics were desired by G1 and G2

	Frequencies		
Attribute	**G1**	**G2**	**Total**
A1	27 *(31.01)*	23 *(18.99)*	**50**
A2	19 *(17.99)*	10 *(11.01)*	**29**
A3	26 *(23.57)*	12 *(14.43)*	**38**
A4	17 *(16.13)*	9 *(9.87)*	**26**
A5	7 *(6.82)*	4 *(4.18)*	**11**
A6	1 *(1.24)*	1 *(0.76)*	**2**
A7	1 *(0.62)*	0 *(0.38)*	**1**
A8	0 *(0.62)*	1 *(0.38)*	**1**
Total	**98**	**60**	**158**

NB: A1 to A8 are defined in Table 8.1

When the conditions for performing the chi-square test are not fulfilled, some remedial actions can be taken (Weiss, 1995). One possibility is to combine some of the attributes so that the low frequencies are eliminated. For the present analysis, this action was not viable as the meaning(s) attached to the attributes would have changed, or rendered meaningless.

Another option is to drop some of the attributes with low scores so that an analysis using the remaining attributes is made possible. This later option was adopted, and, action on it was taken in respect of the additional attributes (A5 to A8). This was done because many clients did not identify with these additional attributes. Thus the statistical analysis was based on those initial features that were presented to the clients in the questionnaire. By dropping these attributes at this stage of the analysis was not the end of the matter as they were subsequently analysed by qualitative judgement. Section 8.2.4 revisits the issue of these additional needs. Meanwhile, Table 8.3 contains the revised data for the present analysis. With the availability of this streamlined data, which satisfied the axioms of the chosen test, the task of performing the analysis to test the hypotheses proceeded.

The degrees of freedom (df) for the analysis are given by the product (Weiss, 1995):

$$(R - 1)(C - 1), \text{ where:}$$

R and C refer to total number of attributes in rows and columns respectively.

The degrees of freedom (df.) in respect of the data of Table 8.3 were thus:

$$df = (4 - 1)(2 - 1) = 3.$$

Table 8.3 : Actual and expected frequencies by which some meanings of aesthetics are desired by G1 and G2

	Frequencies		
Attribute	**G1**	**G2**	**Total**
A1	27 *(31.12)*	23 *(18.88)*	**50**
A2	19 *(18.05)*	10 *(10.95)*	**29**
A3	26 *(23.65)*	12 *(14.35)*	**38**
A4	17 *(16.18)*	9 *(9.82)*	**26**
Total	**89**	**54**	**143**

To calculate the empirical chi-square value for the data, the chi-square formula was used. This formula is given as (Siegel, 1988):

$$\chi^2 = \sum_i \frac{(O-E)^2}{E}, \text{ where:}$$

O and *E* refer to observed and expected frequencies respectively.

A yardstick of assessment (critical value) was established with which the empirical chi-square value was judged. This critical value was established using the confidence limit, which was chosen for this research in chapter 4 to be 95%.

From a Statistical Table (Rolf and Sokal, 1969), the critical chi-square value, at 3df @ 95% confidence was: $\chi^2_{0.05} = 7.815$.

Using the foregoing empirical chi-square formula with the data of Table 8.3 gave:

$\chi^2_{empirical} = 2.305$.

A comparison of threshold with empirical chi-square values shows that the empirical value is lower than the threshold.

Since the empirical chi-square value did not exceed the critical value, the null hypothesis was accepted while the alternative hypothesis was rejected. On this basis it was concluded that the scoring of the attributes of aesthetics was independent of client grouping (G1/G2). This means that the frequencies by which the attributes of aesthetics have been defined by G1 and G2 were not significantly different from each other.

Since the distribution of scores of the meanings of aesthetics were not significantly different between the two groups of clients, there was no need to further use the test for differences of proportions to determine those specific attributes with net score differentials that were high. For, any such differentials would by the foregoing conclusion, have arisen by chance.

The analogy of the foregoing comparative analysis was used in analysing information concerning the seven other major needs employed in the research (that is, economy, function, quality, relations, safety, no-surprises and time). As with 'aesthetics', the analyses did not consider the additional features of needs that were identified by the clients. To avoid repetitions, brevity was maintained in the subsequent analyses, which are collated in Appendix L.

8.2.2 An overview of the definitions of eight needs by G1 and G2

The analyses (section 8.2.1 and Appendix L) have shown that there were no statistical differences between the frequencies by which the attributes of needs were required by G1 and G2. The distribution of scores of the sampled clients showed that some attributes were desired more frequently than others. Those attributes that were desired more frequently by the sampled clients might have a higher probability of being required in a construction project, if the whole population of construction clients is considered. What the studied frequencies indicated was the regularity with which attributes have been desired by the sampled clients, failing short of indicating when, and, for which project each attribute will be desired.

While project participants, especially team leaders, may find it useful to know the probability with which needs-attributes are desired, it is also important to know all the attributes and to remember that any of them could be applicable to a construction project. A means for keeping track of all the numerous features of construction needs is in this wise discussed in chapter 9. While the two sampled clients have perceived the meanings of needs with frequencies that are virtually equal they may not desire the same needs with equal magnitudes. Thus some of the subsequent analyses examined the clients' desires for dissimilarity.

8.2.3 Additional meanings of needs expressed by G1 and G2

As mentioned before, the clients expressed some additional meanings of needs, which applied to their projects. Those revealed by members of G1 and G2 are shown in Table 8.4 below. The frequencies by which these additional attributes were expressed are relatively small, not to warrant statistical analysis. Suffice to note them in passing. The deduction made from these additional meanings is reflected in the discussion of Section 9.4.4.

8.2.4 An overview of the meanings of needs expressed by all clients

Section B of the questionnaire had asked the clients to tick meanings that were applicable to the eight generic needs presented to them. The 123 clients identified in section 4.7.5 completed this section of the questionnaire. Their responses were compiled in an attempt to see those aspects of needs that were frequently desired. Table 8.5 shows the compilation.

Numerical values in Table 8.5 show that while some meanings of needs were desired by most of the clients, others were desired only occasionally. The differential frequencies by which the meanings of needs were applicable in the clients' projects may be a suggestion that the clients have varying requirements. Without empirical analysis however the extent of the clients' diversity cannot be foretold from a casual glance of the information in Table 8.5.

Table 8.4 : Additional meanings of needs expressed by the clients

Additional Meaning:	Votes by: G1	G2
Pertaining to Aesthetics		
Building to fit-in and balance with the surroundings	7	4
Building to have the appropriate "feel"	1	1
Building to be user friendly	1	0
Building appearance to comply with planning permission	0	1
Pertaining to Economy		
Energy efficiency	1	1
Pertaining to Function		
Buildings to be meet for different users	0	2
Buildings to be adaptable to users with special needs (e.g. disabled)	0	2
Pertaining to Quality		
Building materials and workmanship to comply with statutory standards (e.g., B.S.)	1	1
Building to be meet for end-users	0	1
Flexible buildings that can easily be translated to other uses	0	2
Pertaining to Relations		
A call for partnering relationships between project participants	3	1
Quick remedying of defects by contractors	0	1
Participants to be handy or easily accessible	0	1
Ability of project team members to adjust to dynamic situations	1	0
Communications	1	0
Pertaining to Safety		
Compliance with CDM regulations	7	2
Pertaining to no-Surprises (Commitment)		
Quick remedying of defective work	1	0
Complete design prior to construction	1	0
Contractor to be able to control subcontractors	1	0
(In)stability of user requirements	0	1
Pertaining to Time		
Forward planning	1	0
Adequacy of brief	1	0
Financial clearance	1	0

Table 8.5 : Frequencies by which the attributes of needs were applicable to the clients' projects

Main Need	Alternative Meanings	Score
Aesthetics	Beautiful looking product	80
	Beautiful interior	53
	Beautiful exterior	62
	Beautiful finishes/decorations	50
	Other meanings attached to aesthetics:	
	1) Building to fit well into its context (i.e. general beauty with a right image)	24
	2) Façade	1
	3) Layout, style and colour	2
	4) Appeal to customers	2
Economy	Lowest price whatsoever	9
	Price of the product to meet a given budget	89
	Reducing tendering costs by inviting few bidders	15
	Balance between capital and maintenance (or life cycle) costs	81
	Maximising taxation benefits	4
	Indication of a firm price with minimal variations	63
	Other meanings of economy:	
	1) Method of procurement	1
	3) Low cost-in-use for occupants; energy efficiency	3
Functionality	Building to be operationally efficient with its intended purpose	119
	Durable building	81
	Keeping existing buildings operational during construction (if applicable)	32
	Other meanings attached to functionality:	
	1) Acceptable to end-users	5
	2) Adaptable to different types of end users	1
	3) Flexible space	1
	4) Low energy consumption	2
	5) Low maintenance costs	1
	6) Meeting set performance standards	2
	7) Design for occupation not for awards	1
	8) Ensure that the brief is met	1

Table 8.5 continued

Main Need	Alternative Meanings	Score
Quality	Quality of the product to match current standards	77
	Innovative design incorporating high/latest technology	28
	The Building to reflect your activities and image	41
	Value for money i.e., desired quality at appropriate price	113
	Other meanings attached to quality:	
	1) Qualitative workmanship (with respect to experience and conformance to BS)	4
	2) Quality to meet Housing Corporation standard (SDS August, 95)	2
	3) Quality to match the image of the client	1
	4) Secure?	1
Working Relationships	Avoidance of disputes	69
	Familiarity with contractor	42
	Desire to be actively involved in your project(s)	88
	Desire to be kept informed about the project throughout its life	80
	Non-confrontational relationship with the contractor	69
	Probity (Internal and Public accountability)	67
	Other meanings attached to working relationships:	
	1) Parties to work as a team (partnering)	10
	2) Contractor to obtain reference from previous client(s)	1
	3) Prompt reaction of contractor to client's requests (e.g. making good of defects)	2
	4) Need for good communications at all levels	5
	5) Client centred, i.e. creating communities	1
	5) Equitable principles	1
Safety	Minimal exposure to risk for the client	76
	Recognition of risks associated with the project	103
	Other meanings attached to safety:	
	1) Safety on site; minimal exposure to risk for labour	6
	2) Compliance with regulations, viz.: CDM, COSHH, LA and H&S (health and safety)	12
	3) Proper vetting of contractors	2
	4) Good housekeeping by contractors	1
	5) Financial	1
	6) Pricing and allocation of known risks	2

Table 8.5 continued

Main Need	Alternative Meanings	Score
Surprises	Clear allocation of responsibilities between you and contractor	99
(I.e. Lack of :)	Flexibility to change the design during construction	33
	Avoidance of claims	76
	Guarantees of, and on construction	82
	Other sorts of surprises:	
	1) Completion of design prior to construction	1
	2) Ensuring the control of sub-contractors	2
	3) Unforeseen ground conditions	2
	4) Know what final product will look like	1
	5) Briefing documents to establish clients' needs and parameters for the building	1
	6) All goes according to plan	1
Time	Timely construction (i.e. being on schedule)	115
	Securing timely planning approvals	56
	High speed of design and construction	32
	Early start	25
	Minimal interference	48
	Other aspects time:	
	1) Realistic schedules	6
	2) Adequacy of brief	1
	3) Obtain planning permission speedily	1
	4) No delay in getting financial clearance	1
Unaffiliated	Product to meet end-user satisfaction: (An additional need mentioned by a client)	1

8.3 Differential magnitudes of desire attached to needs

Given that rank data were used in classifying the clients into G1 and G2, it follows that the overall ranking of needs by G1 and G2 should be different. This conjecture can be observed in the values of Tables 7.11 and 7.12. However, differences in ranking may not necessarily translate into significant differences in magnitudes of desire. For instance, G2 scored economy by a score of 77 while safety was scored 79 (see: Table 7.12). These values mean that safety was ranked higher than economy but can we say that the two scores of 77 and 79 are statistically different from each other? - Most likely not. Therefore the interpretation derived from rank data should be different from that derived from scaled data. Thus the scaled desires of the two clients were assessed for statistical differences.

The quest of this analysis was to determine if the intensities of the needs-desires of G1 and G2 did actually vary. Insignificant differences between their desires may imply that, an understanding of the desires of one client can be used to infer the magnitudes of desire of other clients. On the other hand, significant differences between the desires of the clients would infer that apart from knowing a client's simple preferences, some scaling to determine the amount of desire attached to different needs would be needed.

Being that the scaled needs were on an interval scale, parametric analyses could be performed with their information. Before individual needs were compared their scores as a set were collectively compared between the two clients. The current analyses followed the pattern of section 8.2 except for the use of different analytical techniques. On this occasion the overall distributions of the needs-desires of the two clients were first compared by means of the correlation coefficient, and, differences in the desire of individual needs were assessed using the test for differences of means.

8.3.1 Difference in the distribution of needs-desires belonging to the two groups

In this test, the strength of association (correlation) between the needs-desires of G1 and G2 was assessed. A high correlation would infer an insignificant difference between the overall desires of the two clients. The data needed for the analysis are shown in Table 8.6 and their values were obtained from Tables 7.11 and 7.12.

The pair of statistical hypotheses tested was:

H_{03}: The magnitude of desire for construction needs is independent of the client.

H_{A3}: The magnitude of desire for construction needs is dependent on the client.

Table 8.6 : Scoring of needs by G1 and G2

Need	Score: G1	G2
Aesthetics	43	5
Economy	35	77
Function	65	86
Quality	90	100
Relations	5	24
Safety	100	79
No-Surprises	18	72
Time	12	59

The Pearson product moment correlation coefficient is a popular formula often used for assessing correlation between variables. By adopting this coefficient and using computer facility, (SPSS), the coefficient of correlation between the desires of the two clients was calculated for a two-tailed test to be:

--- Pearson Correlation Coefficients ---

	G1	G2
G1	1.0000 (8) P= .	.5467 (8) P= .161
G2	.5467 (8) P= .161	1.0000 (8) P= .

*(**Source:** Culled from SPSS Output)*

The interpretation to be attached to this output is that (Norusis, 1993): the probability of obtaining a coefficient of correlation of at least 0.5467 in absolute value when there is in fact no correlation between the variables is 0.161. On a scale (0.00 to 1.00) the probability of obtaining the calculated coefficient (0.161) is low. In view of this low probability, the average amount of correlation between the desires of G1 and G2 cannot be attributed to chance. It can thus be said that the need-desires of G1 and G2 are different, being only moderately correlated. The test for statistical correlation is underpinned on the assumption that the distributions being tested are normal. This assumption was satisfied in chapter 7 while scaling the needs-desires of the clients.

The chi-square independence test was used to test the same set of hypotheses in an attempt to corroborate the foregoing outcome. To perform this analysis, the expected frequencies of the desires of the two clients were calculated as in section 8.2.1 (see Table 8.7).

Table 8.7 : Observed and expected scores of clients' needs

	Scoring of need		
Need:	**G1**	**G2**	**Total**
Aesthetics	43 *(20.30)*	5 *(27.70)*	**48**
Economy	35 *(47.37)*	77 *(64.63)*	**112**
Function	65 *(63.87)*	86 *(87.13)*	**151**
Quality	90 *(80.37)*	100 *109.63)*	**190**
Relations	5 *(12.27)*	24 *(16.73)*	**29**
Safety	100 *(75.71)*	79 *(103.29)*	**179**
No-Surprises	18 *(38.07)*	72 *(51.93)*	**90**
Time	12 *(30.03)*	59 *(40.97)*	**71**
Total	**368**	**502**	**870**

The df for the data are: (8-1)(2-1) = 7.

The critical ($\chi^2_{0.025}$) for a two-tailed test was 16.013 (Rolf and Sokal, 1969).

The empirical χ^2 value calculated using the earlier specified chi-square formula was 109.69.

The empirical χ^2 value exceeded the critical value of 16.013. It was greatly higher than the critical value as to warrant a rejection of the null hypothesis in favour of the alternative. This implied that there was a statistical difference between G1 and G2 in the net desire of needs.

8.3.2 Statistical test for significant differences in the desires attached to individual needs

The foregoing tests have both shown that there was a statistical difference in the scoring of needs by G1 and G2. If that is true, can that difference be attributed to one/some/all need(s)? This question can only be answered by further analysis. Careful examination of the scoring of needs in Table 8.7 reveals that the net difference in the scores assigned to the various needs varies. While some of these differences are high some are relatively smaller. Probably, some and not all the needs have contributed to the outcome of the previous analysis. To verify this, significant differences between the scoring of individual needs by G1 and G2 were assessed.

The analyses started from the need that showed the greatest net difference in scale values between the two clients and proceeded downwards until an insignificant difference was established. Accordingly Table 8.8 ranks the differences between the respective needs as desired by G1 and G2.

Table 8.8 : Scoring of needs by clients

		Scores		Rank
Need	**G1**	**G2**	**|G1-G2|**	**Order**
No-Surprises	18	72	54	1
Time	12	59	47	2
Economy	35	77	42	3
Aesthetics	43	5	38	4
Function	65	86	21	5
Safety	100	79	21	5
Relations	5	24	19	7
Quality	90	100	10	8

Being that the desires in reference reflect mean-scores, the test for differences of means was used. In this connection Chapter 7 established that the standard deviation was the unit of measurement by which the scale values of Table 8.7 were derived. This implies a standard deviation of 1.00 for both scales. With sample mean-scores available and a common standard deviation, the 'inference for two normal populations using independent samples - standard deviation assumed equal' was utilised. This is the "pooled *t*-test" (Weiss, 1995).

8.3.2.1 Testing for significant difference in the desire of 'commitment'

Table 7.11 showed that G1 desired the main need 'no-surprises' by the net score (unstandardised) of 0.21 while and the equivalent intensity of desire of this need by G2 (Table 7.12) was 1.29. Using this information, the data needed for the present analysis were collated (in Table 8.9).

The null and alternative hypothesis tested were:

H_0: $x_1 = x_2$; and,

H_1: $x_1 \neq x_2$.

Table 8.9 : Outlay of data concerning 'commitment'

Characteristic	Information: G1	G2
Mean Score	$x_1 = 0.21$	$x_2 = 1.29$
Size	$n_1 = 38$	$n_2 = 37$
Standard deviation	$s_1 = 1.00$	$s_2 = 1.00$

The test was performed at the chosen level of 95% significance.

Therefore, $\alpha = (1 - 0.95) = 0.05$.

The critical values for a two-tailed test were established at: $\pm t_{\alpha/2}$; with 73 degrees of freedom, where, 73 was obtained from the formula: $(n_1 + n_2 - 2)$.

Accordingly $\pm t_{0.05/2} = \pm t_{0.025}$ @ 73 df $\cong \pm 2.000$.

The pooled standard deviation of the two populations was estimated from those of the samples by the formula:

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}} \text{, where:}$$

n_i and s_i refer to sample sizes and standard deviations respectively.

From this formula, the pooled standard deviation was also unity, that is, $s_p = 1.00$.

The test statistic t was calculated from the formula:

$$t = \frac{x_1 - x_2}{s_p \sqrt{(1/n_1) + (1/n_2)}}$$

By substituting the foregoing values into this formula, t was found to be: $t = -4.675$.

The empirical value of -4.675 fell outside the range demarcated by the critical limits of: ±2.000. Therefore, it was inferred that the two magnitudes of desire pertaining to the two clients were significantly different from each other.

8.3.2.2 Testing for significant differences in the desires of other needs

Testing for significant differences between the desires of the other seven main needs followed the pattern of analysis in sub-section 8.3.2.1. The only difference on each occasion was the numerical value of the numerator of the t-statistic. In view of this similarity, the subsequent computations were aggregated in the compilations of Table 8.10.

Table 8.10 : Differential scoring of needs by G1 and G2

Need	Rank Order	Scores: G1	G2	G1-G2	t-values: Critical	Empirical	Remarks
No-Surprises	1	0.21	1.29	-1.08	±2.000	-4.675	In excess of
Time	2	0.11	1.04	-0.93	±2.000	-4.026	the critical
Economy	3	0.50	1.37	-0.87	±2.000	-3.766	limits of
Aesthetics	4	0.63	0.00	0.63	±2.000	2.727	±2.000
Function	5	0.99	1.56	-0.57	±2.000	-2.468	
Safety	5	1.56	1.41	0.15	±2.000	0.649	Less than
Relations	7	0.00	0.36	-0.36	±2.000	-1.558	critical limits
Quality	8	1.39	1.82	-0.43	±2.000	-1.861	

The computations showed that differences between G1 and G2 in the desire of five needs (No-surprises, time, economy, aesthetics and function) were statistically significant while differences in the desires attached to three needs (safety, relations and quality) were insignificant. The differences exhibited by the clients seem to suggest that more often than not, the desires of the clients were different. For instance, while G2 attached a very strong desire to the aspect of no-surprises, G1 had a very weak desire for this aspect. This and other differences between G1 and G2 tend to suggest that for any client's desires to be fully comprehended, they should be scaled.

The information to be obtained from the scaling of clients' needs has the advantage that, it could be reduced to ranks or patterns, as project disposition may dictate. Being that the desires of G1 and G2 were found to vary and to belong to different distributions, their patterns were further studied to see how they differed.

8.4 Comparative evaluation of the prioritisation of needs by the two groups

Although the scaled desires of G1 and G2 fall on a continuum, extreme limits can be pegged and zones demarcated on this continuum. The standardisation of the scaled needs in chapter 7 had pegged the limits of the clients' desires to range from 0 to 100 where the two values referred to no-desire and maximum-desire respectively. The preferences of the clients as to the most or least desired need or set of needs were then observed.

The preferences of the clients can be categorised into different sub-groups. Masterman (1992) adopted a four-group categorisation in Figure 4.1. O'Reilly (1987) and Chinyio et al. (1998b) suggested a three-group classification. As far as decision making is concerned, the number of groups into which desires could be categorised depends on the decision-analysis technique in use. In view of clients' many needs, O'Reilly (1987) and Moleski (1978) suggested that only (very) essential needs be used in evaluating decision options. This opinion infers a two-fold grouping of needs where essential needs are distinguished from the non-essentials. In line with this suggestion the needs of the two clients were subjectively grouped into the categories shown in Table 8.11. Each need is proceeded by its rating in brackets. It is these ratings that were used in the categorisation process.

Any subjective categorisation is relative and not absolute. A two (or three) fold categorisation can show those needs that are equivocal (O'Reilly, 1987). On the basis of information revealed by Table 8.10 the prioritisation of needs by G1 and G2 can be seen to vary. While G1 has rated few needs on the high side G2 has rated more needs at that level. The analyses of section 8.3 had shown that there was no statistical difference between G1 and G2 in the scoring of safety, quality and relations. Each of the trio falls in the same category in Table 8.11 for both G1 and G2.

Table 8.11 : A Lexicographical grouping of G1 and G2's needs

	Categorisation of needs:	
Category*	**G1**	**G2**
Very Essential	Safety (100) Quality (90)	Quality (100) Function (86) Economy (77) Safety (79) No-surprises (72)
Essential	Function (65)	Time (59)
Desirable	Aesthetics (43) Economy (35) No-Surprises (18) Time (12) Relations (5)	Relations (24) Aesthetics (5)

* *Source: (O'Reilly, 1987)*

8.4.1 Second order categorisation of needs

The eight needs in Table 8.11 can further be categorised into two. In this regard, Golub (1997) distinguished between "objectives" and "means to an end". By this understanding, some of the eight generic needs in this research pertain to the physical products (objectives) while the others pertain more to the process in which the physical products are to be achieved ("means to an end"). By the foregoing distinction, the objectives of the clients can be seen to consist of the needs: aesthetics, function, quality, and safety (of product). The means on the other hand consist of economy, relations, no-surprises, and time. Both sets of needs are important and their accurate identification and evaluation would enhance better decision making in the course of project delivery.

The objectives tend to outlive the 'means-to-an end' (means) as they tend to last with the products. The 'means' come into play especially prior to, and, during construction production and cease to have an impact usually on completion of production. With this understanding, a partial view of clients' requirements was made. By observing Table 8.10 with respect to only the objectives, the pattern of Table 8.12 emerged.

By comparing essential with desirable needs, Table 8.12 suggests that the distribution of needs by G1 and G2 between the two main dimensions is the same. This implies that the main difference between G1 and G2 lies in the way in which they prioritise the other set of needs (the 'means-to-an-end'). Accordingly, Table 8.13 shows that while G2 desired several means-needs highly, G1 did not really place a high concern on them.

Table 8.12 : A Lexicographical grouping of G1 and G2's objectives

	Categorisation of objectives:	
Category	**G1**	**G2**
Very Essential	Safety (100) Quality (90)	Quality (100) Function (86) Safety (79)
Essential	Function (65)	
Desirable	Aesthetics (43)	Aesthetics (5)

Table 8.13 : A Lexicographical grouping of G1 and G2's Means

	Categorisation of needs:	
Category*	**G1**	**G2**
Very Essential		Economy (77) No-surprises (72)
Essential		Time (59)
Desirable	Economy (35) No-Surprises (18) Time (12) Relations (5)	Relations (24)

When either the objectives or 'means' are considered, scaling them would help provide vital information that is necessary for good judgement in decision making. For instance, G1 desired function by a score of 65 - this could be a suggestion that G1 is more interested in products with more rigid and less flexible functional capacity. The utmost desire for safety by G1 might have sprung from intended facilities that will used by many people hence the emphasis on safety. The significance and implication of a high or low desire of a need can only be verified with each client. Thus the scaling of clients' needs can, reveal information that can lead to appropriate further probes.

8.4.2 Discussion

The distribution of needs in Table 8.10 can on its own provide a better basis for decision making in the course of project delivery. If needs are scaled and categorised this way during briefing, then the delivery phase can be approached more purposefully where the priorities attached to needs can be used for relevant decision analysis purposes. For instance, G1 tends to desire safety, quality and function in his/her/their project undertakings more than the other needs. This suggests a greater reliance on design resources at the initial stage. Comparatively G2 has a strong desire for economy, implying a greater use of cost advisers, prior and during the design phases so as to balance the other features of the project with price. G2 also desired no-surprises and time on the high side, his/her projects more formal and to run on strict timing amongst other considerations. Comparatively a greater leeway in the delivery of G1's product is suggested by the relatively low desires of the 'means' needs. If necessary the achievement of some of these low-rated needs can be sacrificed for the attainment of safety and quality in G1's projects.

Obviously the development of each construction project would be unique. However the scaling and prioritisation of needs would help supply information that can be beneficial to project decision-makers. It would also provide clients with a basis to either perceive better or verify their needs-desires, and, in-turn provide a better basis for effecting project control.

8.5 Attributes underpinning the desires of the clients

This section investigates for predominant factors underpinning clients' differential needs-desires. The analysis seeks to associate (some) factors with clients' desires, especially the desires in respect of essential needs. The data analysed were generated from the second questionnaire where information was collected from only those clients whose needs-desires had earlier been scaled and analysed, namely: members of G1 and G2.

Having been given a checklist of 23 attributes the clients who participated in the research rated the extent to which they influenced their needs-preferences. Table 7.21 and Figure 7.2 showed the collation of scores expressed by the clients, pertaining to the impact of these attributes on their preferences. The ratings attached to the 23 attributes by the two clients were discriminated on the basis of amount of influence.

8.5.1 Predominant attributes influencing the two groups

The investigation first sought to identify the predominant attributes, which underpinned the needs-desires of the clients. In this regard, the rating of the 23 attributes by the clients were categorised into the two groups of: Predominant versus Non-predominant. Being that high/low are relative terms it was difficult to specify a limit that could be used for a statistical test. Thus a heuristic was employed at this stage of the analysis.

To discriminate between the two sets of attributes, (i.e., predominant and less predominant), a cue was taken from the previous categorisation of needs where they were grouped into the two classes of essentials and desirables. This time around the mean-score of fifty was subjectively used as a threshold mark for classifying the factors as either predominant or not. By this decision, attributes which have been rated by a mean score in excess of fifty were classed as predominant while those scoring lower than this were classified otherwise. Figure 8.1 shows the demarcation of the attributes into these two groups.

Figure 8.1 shows that there were six attributes on which the two sets of clients were agreed as being predominant. These are F9; F10; F13; F14; F17; and, F18. A further four attributes were rated high but by only one client on each occasion. These are F2 (rated high by G2); and, F6; F7; and, F16 (rated high by G1). Incidentally F8 was scored 50.00 by both clients.

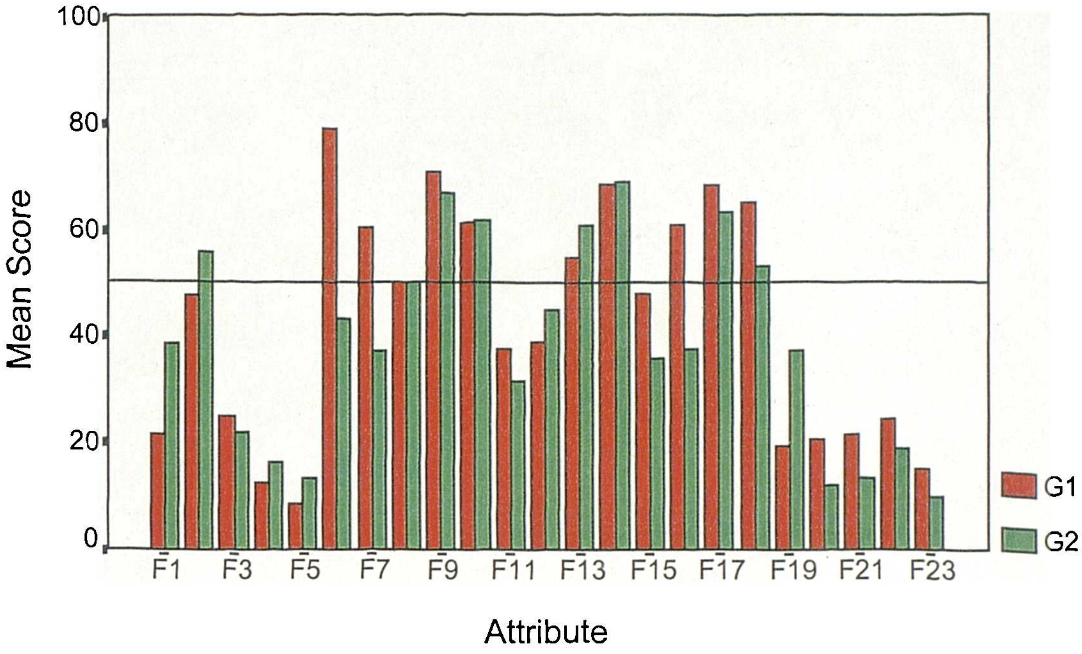


Figure 8.1 Mean scoring of 23 attributes by G1 and G2

8.5.2 Difference between the two groups in the scoring of predominant attributes

In a situation where one client rated an attribute as predominant and the other did not could we say that a statistical difference exists between the ratings of the two clients? This question is particularly intriguing when F2 is considered, where: G1 has scored this attribute (48% approximately) below the threshold mark of 50.00 while G2 scored it as a predominant attribute (56%). If these scores are tested for 'difference of means', and the net difference between the scores of the two clients is found to be statistically insignificant, which way can this factor be described? - Predominant or non-predominant? To resolve this and other types of conflict the ratings attached to some few attributes were tested for statistical differences, and, decisions were made on the basis of unique circumstances surrounding each analysis.

Being that the investigation was concerned more with predominant factors, the statistical tests were restricted to those attributes that were rated as predominant in Section 8.5.1. Table 8.14 shows these factors where its information was culled from Table 7.21. Figure 8.2 shows a diagrammatic representation of the mean scores of Table

7.12. The supposition was that the threshold score of 50.00%, used in classifying the attributes (as predominant or non-predominant), is reliable and acceptable.

Table 8.14 : Rating of predominant attributes by G1 and G2

Attribute:	Collation of Scores: G1 Mean	S.D	N_1	G2 Mean	S.D	N_2
F2: Business function	47.86	36.95	28	55.83	32.43	24
F6: Type of facility built	78.97	19.70	29	43.33	29.73	24
F7: Type of development: (new or refurbishment)	60.34	28.47	29	37.50	23.27	24
F9: Type of clients/customers	70.69	24.77	29	66.67	24.79	24
F10: Expressed desires of customers	61.38	30.56	29	61.82	23.63	22
F13: Needs of other users of the Facility	55.00	26.46	28	60.83	25.01	24
F14: Special users' needs (e.g. disabled)	68.62	23.86	29	69.17	19.09	24
F16: Advise of in-house professionals	61.07	26.57	28	37.83	27.95	23
F17: Planning regulations	68.62	23.86	29	63.33	21.80	24
F18: Building regulations	65.17	28.11	29	53.33	25.48	24

Using the data of Table 8.14 the pair-wise differences in the mean-scores of the ten attributes were statistically assessed. The particular test employed was the inference for the means of two normal populations using independent samples - with standard deviations not assumed equal. Notably the analyses considered the corresponding standard deviations of the mean-scores, a constituent information that was not utilised in Section 8.5.1.

Since the statistical means and standard deviations on hand pertained to samples and not entire populations; and, being that the sample sizes of G1 and G2 were small (less than 30), procedures of the t-distribution as opposed to the normal-distribution were used. The analyses follow hereunder in the order in which the attributes have been listed in Table 8.14.

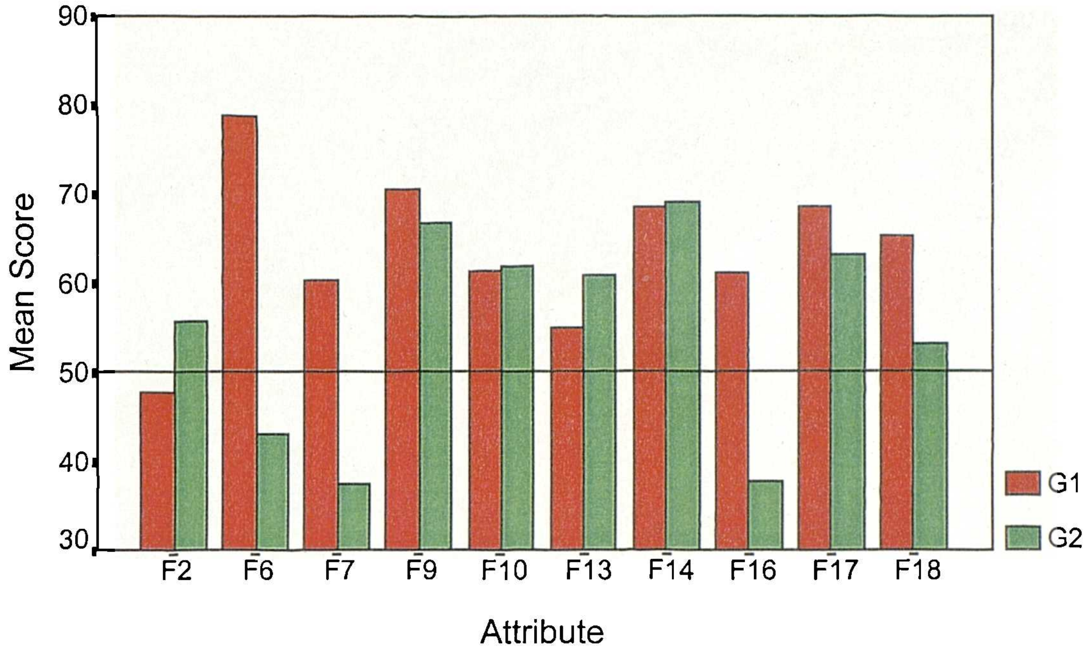


Figure 8.2 : Relative scoring of predominant attributes by G1 and G2

8.5.3 Testing for statistical difference in the scoring of 'Business Function'

The data in respect of this attribute were culled from Table 8.13 and are shown in Table 8.15. The hypotheses tested were:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$

The alternative hypothesis implied a two-tailed test, thus, $t_{\alpha/2}$ was actually employed. The significance level is $\alpha = 0.05$ (@ 95% significance).

Table 8.15 : Scoring of business function by G1 and G2

	Information	
Statistic	**G1**	**G2**
Mean ($\bar{x}_i$)	47.86	55.83
Standard deviation (s_i)	36.95	32.43
Sample size (n_i)	28	24

The degrees of freedom (df) which are rounded up to the nearest whole number were obtained from the formula (Weiss, 1995):

$$\text{df} = \frac{[(s_1^2 / n_1) + (s_2^2 / n_2)]^2}{\dfrac{(s_1^2 / n_1)^2}{n_1 - 1} + \dfrac{(s_2^2 / n_2)^2}{n_2 - 1}}$$

Where: s_i and n_i refer to sample standard deviation and size respectively.

From the foregoing formula: df = 49.964 ≅ 50

Therefore the critical values of $\pm t_{0.05/2} = \pm t_{0.025}$ @ 50 df ≅ ±2.021 (Rolf and Sokal, 1969).

The *statistic* to be compared with one of the critical values is (Weiss, 1995):

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s_1^2 / n_1) + (s_2^2 / n_2)}}$$

By substituting the values of x_i and s_i into this formula, the empirical value of t was found to be: $t = -0.828$.

This computed t value falls within the range of the critical values of: ±2.021. Since the empirical value of t did not exceed the critical value of -2.021, it was concluded that there was no statistical difference between G1 and G2 in their rating of business function.

The subsequent analyses in respect of the other nine attributes followed the pattern of this section where the same notations applied. To avoid repetitions, these subsequent analyses are given in Appendix M. Of the ten comparative analyses in respect of mean-differences only three (F6; F7; and, F16) showed a statistical difference in the rating of attributes by the two clients (see: Appendix M).

From the foregoing, the scoring of the ten attributes classified as predominant by G1 and G2 can be divided into two main groups, that is, those few (3) whose scoring by the clients were different and the other 7 whose scoring by the clients were not statistically different. Figure 8.2 shows that, the three factors, which were rated differently by the clients, were rated high by G1, and low by G2. This contrast represents the main difference between these two clients as far as the impact of the predominant attributes was statistically concerned.

If the threshold line of 50% is considered in Figure 8.2, F2 would be rated below this line by G1 while G2 would rate it above the critical line. However there is no statistical difference between G1 and G2 in the scoring of this attribute. Are we to assume that this attribute has a predominant (or non-predominant) impact on the clients. For simplicity, the mean score of this attribute as rated by both clients was used as criterion of judgement. Using the original scores provided by the clients, the mean score of $F2'$ (being the combined score of G1 and G2) was calculated to be 51% (approximately) - rendering it a predominant attribute.

8.6 Factors influencing clients' needs

Section 4.4.2 had indicated that factors, which tend to explain differences in human needs, could stem from:

1. Culture (Sociological);
2. Economic considerations;
3. Personality differences;
4. Legal Considerations; and,
5. Political considerations.

In addition to these five, a sixth category of *'project induced'* factor was added by the researcher to accommodate some attributes that pertained to the particular project at hand.

The predominant attributes established in section 8.5 were subjectively allocated to the six factors by the researcher. An illuminating picture emerged from this exercise. Table 8.16 shows the insight.

Subject to validity, the compilation in Table 8.16 suggests that the needs-desires of the studied clients were influenced more by cultural considerations; with 50% of the ten predominant attributes being attributable to this factor. The other factors that had a high effect on the studied clients pertained to legal (20%), personality (10%) and project-induced (20%) determinants.

Economic and political factors seem to have had a far lesser impact on the requirements and priorities of the clients. Section 8.5.1 had noted the scoring of F8 by both clients that, it fell on the critical value of 50.00. If given the benefit of doubt and rated as predominant, F8 would belong to the category of 'project-induced' factor, a consideration that does not change the conclusion in respect of the information of Table 8.16.

Table 8.16 : Predominant factors underpinning the values of the clients

	Distribution of predominant factors	
Origin	**G1**	**G2**
Socio-Cultural	F9; F10; F13; F14; F16	F9; F10; F13; F14
Economic		
Personality	F2;	F2;
Legal	F17; F18	F17; F18
Political		
Project-induced	F6; F7; *(F8)*	*(F8)*

NB: F2; F6; etc. are as defined in Table 8.14

In overall it can be said that socio-cultural factors exert a greater influence on the needs-desires of construction clients, and that, their effect varies with clients. While they influenced both G1 and G2 to like their project objectives with high magnitudes they only influenced G2 (and not G1) to like many of the means strongly.

8.6.1 Linking of influential factors with needs

The ultimate quest of the research was to associate factors with needs-desires, but not to prove causality. Hypotheses can be developed and on their basis another research can be designed to test the relationship of the identified factors and the desires of the clients for causality. Such a research design, (like an experiment), would differ from the approach used in the present investigation.

Having identified the major factors influencing the construction clients in their desire of needs, an attempt to associate these factors with some requirements was made. The association was limited to the relationship(s) between predominant factors and essential needs. In this respect Figures 8.3 and 8.4 show respectively the factors that underpinned G1 and G2 in the desire of needs.

Predominant influences: Socio-cultural; Personality Legal; Project-induced	→	**Major Needs:** Safety; Quality

Figure 8.3 Predominant factors influencing the essential needs of G1

Predominant influences: Socio-cultural; Personality Legal; Project-induced	→	**Major Needs:** Safety; Quality; Economy; Function; No-Surprises; Time

Figure 8.4 Predominant factors influencing the essential needs of G2

At a minimum information from Figures 8.3 and 8.4 suggest that similar factors influenced the needs of the two clients but the type of influence varied. If so, what may be necessary is a means of establishing which factors are influencing each client and how they are specifying the desires of that client on each occasion.

At the moment, only associations between the identified factors and clients' major needs can be specified. Another investigation may be necessary as a follow-up on the present one, to check if clients' needs are actually caused by the identified factors. That research will be designed to specifically test for a causal relationship between the factors and needs.

8.7 Summary

The chapter has analysed the differences attached to needs by G1 and G2. It was discovered that their priorities could be grouped along the pattern: very essential; essential; and, non-essential needs. The distribution of eight needs (aesthetics, economy, function, quality, relations, safety, no-surprises and time) into the essential versus non-essential categories by G1 and G2 were found to vary. However the sub-set of needs described as objectives were rated as essential by both clients, and, the other subset (means) were rated differently by the two clients. Thus variation in the tastes of the clients was in respect of the more *ad-hoc* set of needs (means), which pertain to the initial and production phases of project delivery.

Predominant factors underpinning the priorities of the sampled clients were delineated and compared. Eight attributes, mostly sociological, were found to have influenced both clients. A further three attributes, mostly project-induced, influenced only G1 whereby the number of needs desired highly by this client was reduced. On this basis the causal relationship between the predominant factors and essential needs was advocated as an idea for further research.

CHAPTER 9

DISCUSSION OF FINDINGS

CHAPTER 9 : DISCUSSION OF FINDINGS

9.1 Introduction

In this chapter the research outcomes are discussed to provide the basis upon which the findings are to be weighed. The validity of the findings and the inference drawn therein are outlined. The efficacy of the tools used is also discussed. The main subheadings of the discussions are structured in accordance with the four objectives cum hypotheses identified in chapters 1 and 4.

9.2 Intransitive choices by construction clients

The method of eliciting preferences from construction clients via pair-comparisons was successfully utilised in this research and in studies conducted by Fawcett (1998). There is however no any other report to indicate that the method has been used elsewhere in construction practice. Although its practical usage may face the problem of acceptability as some clients may find it cumbersome, there is no indication whatsoever that the concept is unwelcome. More so, computer applications can ease the utilisation of this method, as illustrated by Fawcett (1998).

An encouraging response rate of 22.43% was obtained from those approached for participation in the research. If these one-fifth of clients could respond to the questionnaire in an investigation where they were not going to derive a direct benefit, it is most likely that both they and other clients will find pair-comparisons more acceptable, when utilised formally in the course of their project development.

Consistency of choice on the part of construction clients was analysed in a bid to assess the reliability of the information, which they had supplied. If the information supplied by clients in respect of their needs were unreliable then clients' statements will not be acceptable as the sole basis of generating yardsticks for construction project decision making. This would mean that a supplementary means of identifying or verifying decision-making criteria will have to be established before construction facilities can be engineered to the optimal satisfaction of clients.

If on the other hand construction clients do have a precise understanding of their requirements and can state them consistently, then yardsticks for construction project decision making could be developed straightway from the information they supply to project participants.

In assessing the severity of any set of intransitive choices, the confidence limit used can affect the reliability to be attached to a given piece of information. The adoption of 95% as confidence limit in the present research was in line with literature, deemed to be adequate. For practical purposes, a higher level of sensitivity may be used.

According to Kendall (1970), the making of intransitive choices can arise from a momentary lapse of concentration on the part of the client who had supplied the information. Should a client supply intransitive information, the project team leader or other project team members in charge of the project should point-out the anomalies and seek to verify the most accurate information from the client. When that happens and the intransitive preferences are corrected, the revised information could be used in delivering the desired product. On the other hand, there are some intransitive choices that cannot be rectified easily. Such intransitive choices could be encountered where the client's needs lie in two or more dimensions and are thus difficult to compare. Either way, the usage of paired-comparisons coupled with a search for reliable information through intransitive choices can lead to questions that would help service providers understand clients' needs better.

9.2.1 Understanding clients' requirements

The need to understand the needs of construction clients more accurately and proceeding to achieve them optimally in project schemes, is relatively more urgent on the part of construction producers when compared with other production sectors, say, the automotive industry. Car manufacturers produce en masse by targeting large samples or populations with the anticipation that consumers will buy. Thus their (car) production can make do with average consumer taste. On the other hand construction production, except for property development, usually concerns a client and a (main) contractor on a one-to-one relationship. Each construction client specifies a (unique) set of requirements to the producer *ab initio,* and, expects the later to supply the desired product(s). The current vogue is for (some) clients to desire a dream house where specific or peculiar tastes are reflected. With this attitude in mind, it becomes easy for clients to pick-up faults with products that have not met their entire expectations, and, to claim: 'this is not what I wanted'. In contrast, such a client except on few instances can only buy a car as it is offered in the market.

Although there is a construction property market where clients can purchase ready-made products, some clients still choose to build from scratch. This trait suggests that the market does not offer them products that are fully satisfactory. Also, due to high costs, the market cannot on most instances supply certain products (like airports, dams, warehouses, factory buildings, etc) prior to demand. These types of products have to be produced only when needed. Therefore some construction clients will continually have to specify their needs at project inception, and will always expect and/or rely on producers to identify their requirements accurately and achieve them where possible. A major demand on the construction industry therefore, is that it should be able to evaluate its clients' requirements accurately. (Diverse) tools for evaluating clients' needs should be made available, and construction personnel should be trained on using them.

9.2.2 Need to evolve ways of eliciting correct information

While construction practitioners and literature may agree that accurate information is vital for project success, there is no standard yardstick for evaluating the information supplied by construction clients. This research sought to provide a step in that direction by testing a tool (intransitive choices) that could be used in practice. The information generated via the pair-comparisons provided a basis for checking if construction clients were making inconsistent choices concerning their needs. Inadvertently then, pair-comparisons are at a minimum useful for checking the validity of information supplied by clients. If this technique is therefore used to ascertain that a particular client has supplied unreliable information the underlying reason for making the inconsistent choices should be investigated.

The present research did not investigate further into why inconsistent choices were made by some clients because of two reasons. The first reason is in relation with the few clients who were statistically assessed to have made very high intransitive choices.

Being that the information supplied by the studied clients were used for scaling their needs, and, that only 8 out of 123 clients (6.50%) were highly intransitive, it was decided that data from these eight clients be dropped from the further considerations in this particular research.

The second reason pertained to the possible depth of inquest that may be involved. According to (Kendall, 1970) there are several reasons that can lead a client into making intransitive choices. Isolating one out of several reasons takes times and involves the usage of many resources. Thus the making of intransitive choices by clients in respect of comparing only eight needs was seen as a challenge worth investigating as there may be some specific underlying reasons why these clients could not differentiate a few needs. The task was thus left for a future research where an in-depth study of these clients, especially the aforementioned eight, might be made if they agree to participate in such an ensuing investigation.

9.3 Classification of construction clients

The empirical classification of construction clients in chapter 6 did group the clients into four needs-based classes. Arabie and Hubert (1996b) suggested that "any selected solution be interpreted within the context of the area of research". The four groups that emerged from the cluster analysis were interpreted as representing major groups of clients with each major group (possibly) having its sub-groups.

Some of the rigours of customary statistics like: test of significance, probability modelling etc were not employed in the analysis that led to the needs-based classification of construction clients because, such considerations are yet to be fully developed in this field. This prompts the question: why use a blunt tool just to classify construction clients into needs-based groups? The reason was hinted in chapter 2, where it was noted that some clients do not exactly know what they want (Potter, 1995). If therefore some clients find it difficult to decipher their construction requirements, then construction professionals should help them unravel their needs, as a Doctor would help a sick person identify an ailment.

A line of enquiry for helping clients to identify their needs was explored in this research. It involves studying the clients' needs in general and establishing a finite number of patterns of priorities. Discriminant functions underpinning each priority-pattern can then be established (Skitmore and Mills, 1999). Thus, when clients who cannot specify their construction needs are encountered, their underlying characteristics can be used in conjunction with the discriminant functions to associate them with a known priority-pattern of needs (Chinyio and Olomolaiye, 1999).

9.3.1 Clustering Algorithms

There are several algorithms for performing a cluster analysis, and they all vary in approach. For an algorithm to recover a structure inherent in another data set very well, the structure of that data must be similar to that of the original hypothetical data upon which the algorithm was derived. Most practical data may not match these underlying data structures and hence the practical grouping of objects by any clustering algorithm could turn out to be less optimal.

Faced with this difficulty the present investigation tried several algorithms and compared their outcomes before the best result was selected. 'Best' in this case being the highest level of homogeneity between grouped clients. The availability of computing facilities enabled such multiple analysis to be made. The approach of the research might have leaned it toward making the statistical Type I error.

9.3.2 Stopping rules

The stopping rules which are further needed to delineate the number of classes in a dendrogram may not corroborate each other, as different stopping rules can specify different groupings in a given dendrogram (Milligan and Cooper, 1885). The difficulty therefore is in knowing which rule would best identify the exact groupings in a dendrogram. Mojena's rule was chosen as a rule of thumb because of its simplicity and also due to the factor of familiarity as it has been used before (in Chinyio et al., 1998a).

9.3.3 Limitation of the clustering software

The software available to the researcher was limited in that it could only classify the clients into exclusive groups. A package that can support overlapping clusters might have produced sub-groupings of clients that matched each other better. Also, by using an agglomerative instead of a divisive approach, it is not clear if the efficacy of the output was affected in any way.

However, the main difficulty in the analysis concerned the number of needs upon which the clients were compared. In a monothetic classification where only one function is used as distinguishing criterion, the classification process is easy and can even be done manually. When two or more discriminant functions are involved, it becomes extremely difficult to merge their combined effects. The data reduction techniques previewed in chapter 6 might help in providing better outcomes if used as supplements in polytethic classifications. One of these techniques, 'multi-dimensional scaling', was applied on the research data but unfortunately it could not cope with the high number of clients (115) involved in the investigation. So the effort was aborted.

9.4 Identification of construction clients' needs

In answering sections B & C of the first questionnaire the clients that were surveyed reflected their perceptions of needs. Although there are several meanings, which could be attached to a generic need, the frequencies by which these meanings were applicable to two (typical) clients over 37/38 projects respectively were statistically similar. The chi-square test, which was used in reaching this conclusion, is not very robust and is thus subject to 'Type I' error. Therefore the outcome of the analysis was not interpreted in the strict sense. Despite this shortcoming the chi-square test was employed, because the nature of the data acquired in the course of the research did not meet all the conditions for performing more stringent statistical tests.

Instead of dwelling on numbers, section 8.3 simply concluded that the different meanings of needs were applicable to both G1 and G2. If a projection is made from this conclusion, it would infer that all meanings of needs are applicable to all construction clients. This inference is based on the understanding that some meanings would be more emphasised in certain projects while some others would be de-emphasised in other projects. Thus, construction producers should strive to identify those meanings of needs that are applicable to each project.

9.4.1 The tool of paired-comparisons

The adoption of paired-comparisons in eliciting the preferences of the clients demanded that respondents had to express their preferences several times. However, the way the technique was applied in Fawcett's (1998) research provided a potential usefulness for construction practice. In this regard computer applications eased the difficulties involved in the usage of the tool. If the technique is therefore adopted for construction practice, computer applications can help ease its implementation.

9.4.2 Setbacks with self-inventory instruments

There is always a possibility of response bias in answering questionnaires (Alderfer, 1969). Guildford (1959) gives the following potential setbacks of using self-inventory questionnaires, especially as pertaining to psychometric scaling:

1. Respondents may not know themselves well enough as it is expected;
2. Preferences could be dynamic and not static;
3. Interpretation of terms could vary from person to person; and,
4. Respondents could provide false information.

These setbacks, if they come into play, could introduce bias in the data supplied thereby affecting its validity. Efforts to minimise their potential effects were thus made, as reported below.

9.4.3 Proactive effort to minimise the possible effects of response bias

Having procured several projects in the last five years (see Table 4.6), most of the construction clients approached for participation in the research could be classed as 'experienced'. They were thus very likely to be conversant with the subject matter of the research. Also, responses were sought from highly placed management staff, where corporations were concerned, in an attempt to ensure that those who replied had the information, capability and authority to speak for their organisations. Responses were accordingly provided by personnel who included: (Assistant) Chief Architects; (Assistant) Chief Quantity Surveyors; Managing Directors; Secretaries; Technical Services Managers/Directors; Project Managers, etc.

Clients were asked to report on individual projects. This step was taken to control the effect of changing needs, where clients could have mixed-up the needs of several projects. The clients were also asked to define their needs (in section-B of the first questionnaire) so as to avoid confusion in the usage of terms between the different respondents.

With human needs being variant and dynamic, a scaling of their needs can only be valid for some time. Thus the desires of a client might have to be evaluated on a continuous basis if the results will be used for decision-making in the course of project delivery. It is specifically necessary that the needs of a client be identified and scaled as each project is initiated in order for good construction project outcomes to be obtained.

The issue of supplying false information by clients is rather more difficult to control. If clients choose to lie, then one cannot stop them. Chapter one had assumed that respondents would supply the correct information. Being that clients were not unduely coerced into the research, but requested to do so willingly, it is most likely that they supplied their information sincerely. In practice a client would want to supply the right information, as he/she is the ultimate beneficiary of the product of which the information is generated. With the foregoing efforts, the possibilities of introducing deliberate bias in the generation of information were kept minimal in the research.

9.4.4 The need for establishing an evolving checklist of clients' needs

The individual priorities of the clients were found to vary, for at least they could be segregated into four need-based groups. Tables 8.1 and 8.5 showed how some needs were desired more frequently than the others. The frequency values, revealed in these Tables, seem to confirm the opinion of some scholars that: needs vary with individuals (Weihrich and Koontz, 1993; Albretch and Bradford, 1990). An inference from this opinion is that clients and their needs cannot be treated as unitary (Cherns and Bryant, 1984), but, pluralistic (Green, 1996). Due to clients' diverse preferences therefore, project teams should endeavour to identify the requirements of each client on an individual basis. The thrust is to be able to identify each client's exact requirements. Such identification will help in tailoring the supply of products. However, no model exists for identifying or evaluating the particular needs of construction clients.

One way in which the needs of a client can be established is to ask or probe, as would a Doctor to a patient, a Mechanic to a car-owner seeking repairs, an Employer to prospective employees, etc. However, expert opinion suggests that construction professionals often adopt an over-simplistic view of clients (Green, 1996; Beeston, 1984), and, the appraisal of their priorities has often been ignored (NEDO, 1988; Hughes, 1992a). This attitude of construction professionals may partially be accountable for the non-achievement of clients' needs in project schemes. Several questions can be posed. These include the following (Chinyio et al., 1998c):

- What are clients' needs, and, how can they be identified, and or, evaluated?
- Why are clients' needs, hitherto not adequately evaluated by clients' advisers in project schemes?
- Can clients' satisfaction be improved or optimised, by the conscious attainment of their needs?

The likelihood is that, a detail evaluation of clients' needs at project inception will lead to a greater level of achievement of these needs in construction production. This will in turn lead to greater clients' satisfaction.

Effective probing of needs with clients demands artistic and behavioural skills. However, the process can be eased by the availability of a checklist, which can be used as occasion demands. The study sought to establish such a checklist from clients' responses. Within the time limitations of the research, the literature review conducted did not fully define clients' requirements as more were discovered in the practical survey.

Table 8.5 consists of 75 meanings of needs as established in the study, being a combination of requirements generated from both literature and the client survey study. This checklist can serve as a reference source for identifying future clients' requirements. The initiative of the research was to generate such a checklist *en-route* to developing a computerised version for construction practice. If this checklist is embraced for construction practice, it could be used as a memory jogger for spotting clients' needs during project formulation. The checklist would greatly assist those clients who find it difficult to express their needs.

Since needs vary over time, then while the checklist in Table 8.5 is tenable during the late-nineties it might become obsolete sometime in the 21st century. This dynamism calls for the continuous monitoring and upgrading of needs especially the priorities attached to them. The intention at this stage is to establish a dynamic checklist of clients' requirements that would be updated on a regular basis. The evolving checklist can be encapsulated in a computerised information system, which can enhance its quick updates.

The limitation of the sample size upon which the checklist in Table 8.5 was generated is acknowledged. A larger sample of clients might reveal more needs, thus reinforcing the need for the continuous updating of this checklist. While the checklist might not be exhaustive, it is valid in that it depicts the requirements of many clients.

9.5 Measurement of clients' preferences

The desires of G1 and G2 were quantified by the method of paired-comparisons. This adopted method proved to be valuable, in that its measurement reflected the clients' preferences on an interval scale, allowing for parametric analyses to be performed on the resulting data. The representation of the clients' preferences on an interval scale enabled insights into the pattern of their desires to be studied.

By adopting paired-comparisons in scaling the needs of the clients, the evaluation had supposed that if any one client were repeatedly asked to choose between a set of needs, such a client would have displayed ratings similar to those of the sampled clients (either G1 or G2). From the comparative-judgements repeatedly expressed by these clients, the relative magnitude of desire attached to the different needs by G1 and G2 could be generated. Thus, the scaled values of needs, as computed in chapter 7, depicted those of two typical clients.

According to the scaling result, the needs, which were desired most by the clients, were quality, safety and function. This outcome agrees with the findings of Kometa (1995) that quality, safety and function are clients' predominant needs. This also contrasts with some opinions in literature that economy and time are clients' predominant needs. Clients do not want their needs to be assumed (Jenks and Bacon, 1981; Dickinson, 1979). Therefore, client advisers who always assume that cost and time are clients' primary needs may need to justify their opinion with an evaluation such as the one employed in chapter 7.

The construction project tasks of design, drafting of specifications, selection of contractors, implementing project control, etc should be dependent (variables) on clients' needs. Each client's values, if established, should dictate how these dependent variables are to be combined in a particular project. By this linkage, clients' needs are independent variables that must be evaluated. Once done, the dependent variables can be moderated accordingly. In contemporary project practice however, the dependent variables are often planned-for without the adequate evaluation of the needs upon which they (must) depend. This might explain why clients' needs are not fully achieved in contemporary project schemes, and, why clients' are in turn dissatisfied with their project outcomes. Masterman and Gameson (1994) identified the lack of evaluation of clients' priorities as a missing link in briefing. This research is a step towards bridging that gap.

9.5.1 A comparison of scaled needs from different measurements

The pattern of clients' desires arising from the measurement of chapter 7 and in Chinyio et al. (1998b) showed a contrast to that of Masterman (1992) who had shown all needs to be desired strongly. The evaluation in this research indicated that only some needs were desired strongly while the others were desired either moderately or weakly.

A research by Kometa (1995), like Masterman (1992), showed that if clients are given a rating scale for scoring their construction needs they would rate all or most needs very highly. With pair-comparisons the clients are forced to discriminate between the needs such that some of them would eventually be scored very low. Masterman (1992) and Kometa (1995) may each stake the claim of having evaluated clients' needs. However this research can claim to have used a new technique that has shown a different light to those of its predecessors, a feat that can be described as a contribution to knowledge.

9.6 Factors influencing clients' needs

The distributions of the clients' ratings of the 23 attributes presented to them were illustrated in Figure 7.2. Some members of G1 and G2 identified seven extra attributes that influenced their needs. Information in respect of this later set of attributes, were provided by very few clients, numbering nine or less. Thus it was not compared with that supplied by the initial sample of clients due to sampling size. However, the additional attributes revealed by the clients were not overlooked.

All the seven extra attributes were rated high with mean scores in excess of 50.00. Figure 9.1 shows the distribution of the ratings of these attributes. With their rating coming from very few clients, further research with more clients to re-assess their respective levels of impact is needed. In this light the additional attributes expressed by some of the clients and their levels of impact would be verified in a subsequent investigation. This position does not mask the in-exhaustive compilation in which the 23 attributes that were initially presented to the clients, was ascertained. The limitation of the research to 23 attributes was based on considerations pertaining to time and parsimony.

The attributes referenced in Figure 9.1 are:

F24: Influence of funding or funders;

F25: Influence of community in which property is based (e.g. improvement);

F26: Political considerations;

F27: Value of property (with considerations like interest rates; lettability);

F28: Other statutory requirements (like: environmental; and, health and safety);

F29: Business planning strategy; and,

F30: Maintenance considerations.

Since additional attributes, which influence their needs were identified by the clients, it can be assumed that the 30 attributes identified in the research may not be exhaustive. Other unforeseen and/or unidentified attributes might be exerting their influence on the clients too.

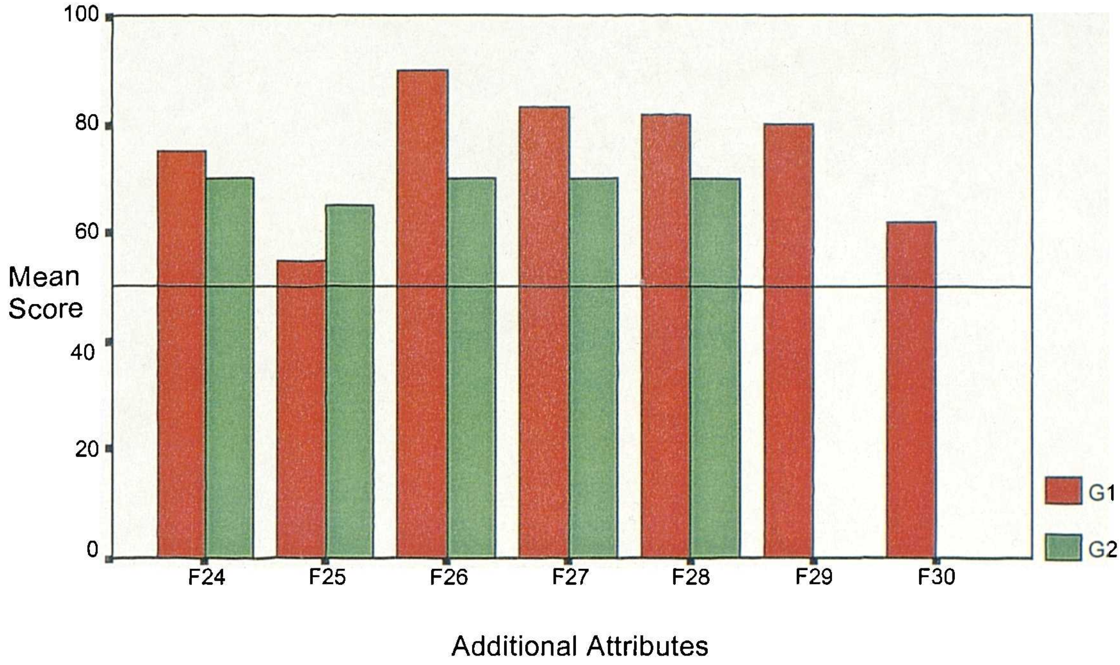


Figure 9.1 : The scoring of additional attributes by G1 and G2

9.6.1 Predominant versus non-predominant attributes/factors

The research concentrated on factors instead of the attributes because, factors are relatively stable and finite in number, while attributes are multiple and dynamic. In line with the suggestions that were made in section 4.2, the research was based on the factors so as to consider fewer issues. Predominant factors were in turn emphasised because their effect outweighs that of the less predominant factors. Being that mean-group scores were used in delineating certain factors as predominant, the outcome can be described as reflecting general and not individual opinion.

Given that an exploratory study was conducted, the research was content with the aggregate scores of G1 and G2. This macro view revealed some patterns in the rating of the factors and evolved questions warranting further research. For instance, do the predominant factors exert their influence on clients one at a time or do they act collectively. Also, do they exert their influence on one/some/all needs? These answers can only be found through further research.

9.6.2 Interaction between factors and needs

The high rating of the same set of factors by the two clients (G1 and G2) was interpreted as an indication that the factors do have an influence on the needs of construction clients. The association of factors with needs was not an attempt to proof causality between them, but an indication that they were correlated. The need for a more stringent test for causality between the factors and needs may thus be rife, having seen in this research that one can be linked with the other. Such a test can only be done via another research designed as a causal-study.

9.7 Inferences

The thoughts developed from the investigation in the light of the foregoing overview are now outlined. Literature asserts that clients' needs are not fully achieved in project schemes, and that, clients are unhappy about it. One main reason for the non-achievement of clients' needs is the inept attitude with which these needs are identified in practice. A guiding principle proffered for addressing this situation is the adoption of more sophistication in the elicitation of clients' needs (Green, 1996). Bearing this in mind, this research sought to establish a basis for evaluating clients' needs more accurately, with the understanding that construction needs are independent objectives which should be the criteria for decision making in construction delivery. The full evaluation of clients' needs involves two things, which are:

1. Identification of all that is needed by a client; and,
2. Evaluation of relative weights to be accorded the identified requirements.

A checklist was developed in this report to help in the identification of future clients' needs and, the psychometric tool of paired-comparisons was adopted for measuring the weightings of these needs. Yet it still remains that some clients do not know what they want (Potter, 1995). At the same time these clients do not want their needs to be assumed, but identified and met. Also, it would seem that even the information supplied by experienced clients cannot be accepted without some form of verification; for less than half of the clients studied in this research were perfectly transitive in their preference choices.

The only way in which needs can be identified or verified, especially when the clients who harbour them do not fully perceive them, is through predictors which can be linked with the individual needs. Such predictors can be used to generate the needs of clients who need assistance in that regard; and, for verifying the requirements of clients who claim to know what they want. In searching for such predictors, three external factors, namely: sociological, legal and personal determinants were observed to have a strong influence on members of G1 and G2.

Although the same set of factors influenced both sets of clients, yet the values of the clients differed. Therefore, it was surmised that personal differences were uppermost in accounting for the differing desires of the clients. We as human beings like different things, be it movies, music, leisure, or whatever. Our different desires transcend to construction facilities. If so, a deeper understanding of human personalities may be necessary before construction clients' requirements can be fully understood. This suggestion tallies with Green's (1996) argument, that: organisations have differing metaphorical dispositions. If one is to transact efficiently with an organisation, it is incumbent that the metaphorical disposition of that organisation be understood and then issues can be discussed with that realisation in the background.

First of all, one must establish a means of identifying the personal trait of a client. The matter could however be very complex. For: when corporations are concerned, the company representative might have a different disposition from that of the firm. The risk there is that the values of the individual could be misconstrued for those of the firm. If clients' needs were established on such a wrong footing, then the objectives of the project would have been mismatched right from the beginning.

Since personality influences values, and, we need to interpret clients' values in the course of construction production, it is imperative that construction personnel be fully prepared for the task of understanding different types of people. Given the training and skills of construction personnel and the resources at their disposal, it can be argued that the construction industry is (potentially) capable of delivering any kind of construction product, as far as that product is fully specified. Therefore, the achievement of clients' needs in construction projects schemes is an attainable task, as long as these needs are fully defined and evaluated prior to product delivery.

However, since clients' needs are hitherto not always fully achieved in project schemes, it can be hypothesised that the identification and/or evaluation of these project needs, is faulty. The inference is that the understanding of clients' motives and personalities by construction personnel is inadequate. For if construction personnel can fully perceive clients' needs the way clients desire them, then construction facilities can subsequently be produced to the maximum satisfaction of clients.

To improve the accuracy of needs-assessment in construction schemes, any identified shortfall in the elicitation of needs should be addressed. In this regard, the syllabi of university departments offering construction courses may need to be updated so as to address the aspect of the human personality and how to understand it. This might involve construction students taking courses in, say: psychology, sociology etc in order to acquire the relevant knowledge. Otherwise, construction personnel may not be fully prepared for the task of ascertaining the values of their clients.

Higgin and Jessop (1963) had hinted that no one individual possesses the knowledge to understand and interpret all clients' needs. The suggestion from this researcher is that sociologists and maybe psychologists could be engaged in the practical elicitation of clients' needs as they can better interpret the interplay of the sociological factors on the clients. Some briefing procedures in America have employed the assistance of these personnel while construction briefs were being developed (see Farbstein, 1978). The foregoing discussion falls in line with the concept of 'bounded rationality', where no single individual is known to have perfect knowledge and understanding.

9.7.1 Limitations

Leedy (1994) had cautioned researchers on the haste to generalise their findings. In this respect, the type and nature of the investigation and the sample size can affect the level to which findings can be generalised. The sample size of 133 as used in this investigation represents a very low percentage of construction clients in the population. The clients surveyed, being few, may not have proffered all the opinions of construction clients in the entire population. It was partly on this basis that an evolving checklist was recommended.

The 133 clients were highly skewed in favour of private corporations and a majority of them reported on residential buildings. It is not exactly clear if this imbalance had influenced the outcome in any way.

9.8 Summary

This chapter has cast a retrospective view at the findings of the investigation. The objective was to provide a basis for assessing the reliability and limitations of the findings, and, to plough a way forward for construction practice in terms of evaluating clients' needs more accurately. The dynamic nature of clients' needs and factors influencing them were brought up, leading to the suggestion that clients' needs and the particular factors influencing them should be identified on a continuous basis, especially, at the beginning of each construction project.

Having seen that clients defined their needs in a similar manner and had similar factors influencing their differing desires for these needs, it was surmised that the aspect of human personality had an overriding effect in the differing desires of the clients. The revision of the current training offered construction students in terms of understanding human personality was considered by the researcher where, a call for the revision of syllabi was made. This revision should consider the incorporation of sociological and psychological principles in the domain of needs-assessment.

CHAPTER 10

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

CHAPTER 10 : SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

10.1 Summary

In competitive markets, suppliers endeavour to outwit one another by determining the precise and latest requirements of their (prospective) customers and supplying products in accordance with the expectations of these customers. The construction industry can learn from this principle by endeavouring to continually understand its clients' needs as accurately as possible. In this light, this research examined the needs of contemporary construction clients in order to ascertain where their current preferences lie and to discover information that would be useful for project decision making, in the course of delivering products that meet clients' numerous needs. Information was therefore collected from construction clients concerning their needs and the preferences attached to them. Factors underpinning clients' differential needs were also identified.

Two questionnaires were designed and used as channels for soliciting the requisite information from the construction clients. The first questionnaire was prepared to elicit information on clients' needs and the priorities attached to them. Using this questionnaire 493 clients were approached for information on the research. They were selected for participation by means of 'non-probability' and 'convenience' sampling. The clients consisted of private-individuals (100), public-organisations (100) and, private corporations (393). 133 clients (22.434%) responded to the initial request of the researcher by replying to the first questionnaire.

The second questionnaire consisted mainly of a checklist of potential attributes, which can underpin construction clients' requirements. The number of attributes listed in the second questionnaire was 23. Through this questionnaire, some corporate clients were asked to indicate the amount of influence each attribute exerted on their project values. Cluster sampling was employed in administering the second questionnaire.

To conduct this type of sampling, the 133 clients who responded to the first questionnaire, were first streamlined to 115, due to either the insufficiency or unreliability of the information they had supplied in the first questionnaire. The 115 clients were then stratified into four needs-based homogenous sub-groups by means of statistical cluster analysis. Two of these groups were then sampled (purposively) for further study in the second phase of the analyses. The two groups ultimately consisted of 37 and 38 members, totalling 75 clients in all. The second questionnaire was sent to these 75 clients, and, 53 of them (70.67%) responded by completing and returning it.

10.1.1 Intransitive choices made by the clients

The first phase of empirical analysis concerned the consistency with which the clients indicated their preference choices over the paired needs of section-C of the first questionnaire. Chapter 5 presented the analysis in respect of the consistency (transitivity) with which 123 clients made preference judgements. The preference choices of the clients were first combined into sets of threes; and, the preferences in each triad were checked for circularity; where: a circular triad indicated an intransitive judgement.

The analysis showed that 50 clients (40.65% of 123) made choices that were completely transitive. 8 clients (6.50%) made a large amount of intransitive choices, rendering their information highly unreliable, and, 65 clients (52.85%) made varying amounts of intransitive choices which were statistically acceptable. In all the information supplied by most of the clients (93.50%) were found to be acceptable, albeit statistically, while that of the remaining few (6.50%) were unacceptable. Consequently, the information of these 6.50% of clients, (i.e., numbering 8), were discarded in the analyses. Thus in all, the information supplied by 18 clients [i.e., (133 – 123 + 8) = (13.53% of 133)] were assessed to be inadmissible for the research.

10.1.2 Cluster sampling of clients

Of the 115 clients whose data were accepted as (statistically) transitive, their respective priorities over the 8 generic needs of the research were found to vary. Being that eight needs were involved, the interactive similarities or differences between the needs-preferences of these clients could not be studied by visualisation. Thus the patterns of the preferences exhibited by the clients were studied via the statistical technique of cluster analysis. The investigation was able to delineate four major classes of construction clients. Two of these classes were sampled out for further study. The two were chosen using the two criteria of sample size and level of similarity of members.

10.1.3 Measurement of clients' needs

The intensities with which the eight needs were desired by the two selected groups of clients were measured by the psychometric technique of paired-comparisons. Although their respective desires were found to vary, the three broad needs of quality, safety and function were found to be highly desirable. Contrary to indications in literature, economy of project schemes and project duration were not found to be strongly desired, though completion on time was a frequently desired feature. The general indication was that while some needs were desired communally by all clients others were desired by fewer clients.

In addition to measuring the needs-desires of the two groups of clients, the extent to which some 23 attributes influenced their desires were quantified. The 23 attributes were compiled from literature and presented to the clients for rating wherein the second questionnaire was developed and used. 75 clients were approached with the second questionnaire. These comprised of 38 clients from group G1 and 37 from G2. 53 of the clients approached (70.67%) responded to the request made in the second questionnaire. 29 of the respondents were from G1 while the other 24 belonged to G2. The scores provided by the clients were aggregated using descriptive statistics where the mean-score of each attribute and its corresponding standard deviation were calculated.

10.1.4 Comparative analyses

The second phase of analyses compared the project values of G1 and G2 for differences. First of all, the definitions attached to needs by the clients were observed. The frequencies by which the different meanings of needs were applicable to 38/37 projects reported upon by G1/G2 respectively were compared using the statistical 'chi-square' non-parametric test. The scaled desires of G1 and G2 in respect of the eight main needs (of aesthetics, economy, function, quality, relations, safety, no-surprises, and time) were next compared. Being that the scaled desires were measured on an interval scale, a parametric analysis was employed. In particular tests for differences of means between G1 and G2 over the eight needs were investigated. The general pattern(s) displayed by the desires of the clients were also observed wherein their needs were categorised into "(very) essential" and "non-essential" groups. The distribution of the eight needs by G1 and G2 into these two categories were compared and contrasted.

Having observed differences in the clients' preferences, similar differences in the factors influencing their needs were investigated. The scores that G1 and G2 attached to the 23 attributes listed in the second questionnaire were in this wise used in evaluating and contrasting the factors. Initially, the major attributes that influenced the two clients' needs were identified through descriptive statistics. Having quantified these attributes using mean scores, 11 predominant attributes identified as having a relatively higher influence on the clients. Tests for 'differences of means' were employed to check for discrepancies in the levels of influence these attributes had on the two clients. The comparative analyses between G1 and G2 were based on the 11 major attributes.

The 11 major attributes identified were also grouped in the six following factors: sociological, economical, personal, legal, political and project-induced. The distributions of the predominant attributes into these six factors, in respect of data from G1 and G2, were observed and contrasted. Following these evaluations, associations between clients' primary needs and predominant factors influencing them were hypothesised.

10.2 Conclusions

The research started with the objective of studying clients' needs, to find out whether construction clients could reliably express their project requirements. It also sought to investigate into (predominant) factors influencing clients' needs. Having collected information from some construction clients, analyses were conducted wherein some observations were made. The conclusions reached in respect of these observations are as given in the following sub-sections.

10.2.1 Construction clients supply inconsistent information

The evaluation of information supplied by the studied clients showed that most of them expressed their values with some inconsistency. Although only a few clients (6.50% of 123) were judged to have provided information that were grossly intransitive, 59.35% of the studied clients made preference statements that were intransitive to one degree or the other. While it can be suggested that most of the clients studied knew what they wanted and could express it with a high or fair degree of precision, it still remains that the information supplied by construction clients cannot be accepted without some form of vetting.

The comparative characteristics of the clients who provided transitive and intransitive information bore a similarity as that illustrated in Figure 4.3. Even some experienced clients were observed to have made some intransitive choices. Significantly, some in-house construction professionals, who answered the questionnaire(s) on behalf of their organisations (see section 4.7.7), also, made intransitive preference choices. The intransitivity of these professionals may be an indication that, knowledge and expression of one's needs is much more difficult than it meets the eye. If so, the development and usage of techniques in the evaluation of construction clients' needs should not be undervalued. This observation reinforces the argument in section 9.7 where it was argued that the training offered construction personnel should be broadened to encompass all aspect of needs-assessment as practised by other disciplines.

10.2.2 Construction clients have similar project requirements

The research observed that there was no statistical difference in the frequency with which G1 and G2 desired the variant meanings of the eight generic needs that were presented to them. All the meanings of needs defined by the researcher were at one time or the other desired by either G1 or G2 or both. However some features of needs were relatively desired, more frequently than the others. Since there was no significant difference in the frequencies by which the meanings of needs were desired by both G1 and G2, it can be concluded that all variant meanings of needs are applicable to all construction clients, with some variants having a higher probability of occurrence than the others.

The inference is that, since no meaning of need was totally disliked, project participants should keep abreast with all features of needs, and seek to establish those that are wanted in the current project. Being that the features of needs are many, and their number keeps growing, one/two/few of them could be missed-out in the course of briefing, through oversight. A means of monitoring all the features of needs was thus developed by the researcher. This consisted of a checklist, which can be used as a memory jogger while identifying the requirements of a client.

10.2.3 Construction clients have different project values

Having split clients' needs (in chapter 7) into 'objectives' and 'means' it was observed that both G1 and G2 attached a strong desire to all the project objectives, but had varying desires for the means by which their objectives should be achieved. Being that project objectives last with construction products and, based on the high scoring of these objectives by the studied clients, *it can be concluded that construction clients do attach* high weighting to project objectives. If so, the generic objectives of *quality, safety and* functional efficiency of construction products should not be undermined in any way in each construction project.

G1 and G2 attached different levels of importance to the 'means' by which their products were to be achieved, suggesting that construction clients varied with respect to the desire of this set of needs. As such, the magnitude of desire attached to 'means' by each client should be assessed wherein psychometric scaling can be employed. The labour effort involved in the scaling would be reduced since only the means and thus a fewer set of needs would be scaled. Alternatively, predominant factors influencing clients' needs can be used to predict the desire attached to different means by a client. It was in this respect that section 9.3 *inter alia* recommended the usage of predominant factors identified in this research for predicting clients' desires.

10.2.4 Some factors have more predominant influence on construction clients' values than others

The 23 attributes studied as per their level of influence on construction clients' values were categorised into two, namely: 'predominant' and 'less-predominant'. The predominant attributes were observed to pertain to sociological, legal, personality and project-induced factors. Economical and political factors exerted a lesser influence on the clients.

The legal and project-induced factors are not determined by the clients, rather, they appear to be imposed on them. Clients are thus somehow obliged to follow the dictates of these two factors. On the other hand clients can moderate or even control to a certain level, the influence of the sociological and personal factors if they choose to do so. This reverse influence can be achieved by a change of environment or taste. A promotion in a job, for instance, can change someone's status and inadvertently change his/her social perspective, which may ultimately be reflected in his/her (construction) needs. A friendly neighbour could offer acceptable suggestions to a (prospective) client on the outlook of the internal finishings of a house. From these examples, it can be surmised that, the forces, which influence clients' needs, are multiple and have varying effect on clients. For each client and circumstance, some factors would exert a greater influence on the project needs. This research has however discovered four factors that are major influences on the clients.

10.3 Recommendations for further research

One by-product of research is the discovery of new areas requiring further investigation (Leedy, 1993). This was found to be true in the present research, where some issues could not be resolved and were reserved for future research. These unresolved issues are explained below.

10.3.1 Reasons for making intransitive choices by construction clients

It was explained in chapter 5 that several reasons could cause a client to make intransitive choices. When intransitive choices have been pointed out to a client who cannot redress the anomaly, the underlying reason for the intransitivity should be ascertained. The present research did not investigate further into why some clients made intransitive choices, leaving the task for future investigation. As explained in chapter 5, the search for reasons underlying intransitive choices involves a depth that can meaningfully be reached through another investigation.

In order to pursue this subject further, the clients who made intransitive choices should be revisited with the data they had supplied. Their intransitive choices should then be pointed out to them and reasons why they made such intransitive choices should be explored. Some causal reasons, which can be reviewed with the clients include mental and/or physical fatigue, lack of interest in answering the questionnaire, difficulty of paired-comparisons, etc. An elaborate checklist of causes can be developed and studied. Suffice to have observed at this stage, that construction clients could be intransitive in their preference statements.

10.3.2 Development of a computerised checklist of construction clients' needs

A checklist of construction clients' needs has been set-up from the findings of the investigation. It can be used in the identification of construction clients' project requirements and thus, as a basis for developing decision making criteria. By conferring with one another, clients and project advisers can use the checklist as a memory jogger for spotting the requirements, which are applicable to a particular project. If the checklist and its usage are adopted in construction practice, the development of project schemes on the platter of clients' needs will be enhanced. If so done, clients' needs will most often be targeted and met, and, the level of client-satisfaction with project schemes would be improved.

However, the checklist remains the concept of an individual researcher. For it to benefit many people, a means of marketing it has to be established. It is in this connection that an evolving checklist of clients' needs is being advocated. A computerised checklist would be able to provide vital information for construction participants.

10.3.3 More attributes influencing the needs of construction clients

Being that the clients identified additional attributes, which influenced their needs, it can be assumed that the 30 attributes identified in the research may not be exhaustive. Some other yet to be identified attributes might have an influence on the clients too. A search for all potential attributes that can influence clients' needs is thus being recommended.

10.3.4 Exact relationship between factors and needs

The linking of predominant factors with essential needs, in this research, was not an attempt to proof causality but indicate that they were correlated. The need for a more stringent test for causality between them is necessary. Being that an exploratory research was conducted the aggregate scoring by G1 and G2 of the factors influencing their needs were studied. This revealed some insightful findings but evolved more questions. For instance, do the predominant factors exert their influence on the needs one at a time or do they act collectively. Also, do they exert their influence on one/some/all needs? These answers can only be found through further research. Another investigation, designed primarily as a causal study, should be conducted to determine the specific nature of the influence of the predominant factors on the desires of the clients.

10.3.5 Decision analysis in construction project development

Chapter 2 revealed a wide range of decision analysis techniques. In the past some optimisation techniques have been recommended for contractor selection (See: Chinyio et al., 1998a; Mustapha and Ryan, 1990; Seydel and Olson, 1990; etc). There is however no similar widespread recommendation of decision analysis techniques for other aspect of construction delivery, like the selection of one from many designs; selection of a procurement method; selection of building materials; etc. Obviously some decision analysis techniques would not be appropriate for all circumstances, however some are potentially viable for construction practice. The only way in which the efficacy of the different decision analysis techniques can be ascertained with respect to construction delivery is through testing-out research. It is thus being recommended that a comparative cost-benefit-analysis of the different decision analysis techniques on the different features of construction be conducted in a bid to discover those techniques that are suitable for different aspects of construction practice.

The acceptance and implementation of the foregoing recommendations would, along with the outcome of this research, improve the accuracy with which clients' needs are assessed in construction project schemes. If clients' needs are accurately assessed and used as decision-making criteria, then project solutions which target and match clients' needs more precisely would be evolved. Consequently, clients would be more satisfied with their project outcomes. If so done, the frustration currently being experienced by some clients would be minimised or eliminated.

10.4 Application of the findings of this research

The findings of this investigation can be used in evaluating construction clients' requirements especially during project inception. The assessment of project requirements would start with the checklist in Table 8.5, which can be used as a basis for identifying or verifying the demands of each client. If a client does not know what he/she wants, the listed needs can give him/her an opportunity to make up his/her mind on different aspects of the project. If however a client has a fair idea of what he/she wants and has stated it, the (updated) checklist can be used to verify that no requirement has been left. The checklist is thus usable as a safeguard, to ensure that no requirement has been left out of a brief.

Having identified the needs of a client, the next task is to prioritise them. The tool of paired-comparisons can be used in the prioritisation. Through pair-comparisons, the needs of a client can be ranked or scaled. If the preference-comparisons are made once by the client, and the choices are checked to be transitive, then the needs of that client can be ranked in order of preference. If the comparisons are done several times by the client, then Thurstone's (1927) principles can be used in full to scale the needs unto an interval scale. Either way, the evaluated needs can be used as the basis for making many project-decisions by the constructor(s) and other persons who are involved in the project.

Sociological, legal, personality and project-induced factors were established (in chapter 8) as having a major impact on the needs of construction clients. These factors could thus be used as a supplement in both the identification and prioritisation of clients' needs. For instance:

- Planning regulations (legal factor) may restrict the type and size of a development;
- A client who moves in the high class of society (sociological factor) would m opt likely opt for very high quality in the specifications of his/her building facility
- Someone who has a flair for beauty (personality) may want to place a high emphasise on the aesthetics of his/her buildings
- Fanciful finishings may be de-emphasised, for obvious reasons, in the completion of factory walls (project-induced factor)

The foregoing examples reflect the influence, which some factors exert on project needs. The potential consequences of these factors on clients' needs should thus, not be ignored in project briefing. While clients' needs are being identified or prioritised, a reference to the influence of these (predominant) factors must be considered.

The tools used in the research thus have a practical benefit in construction briefing. If adopted and used in practice, in the way shown in this document, the level of success of construction schemes would be improved. In a subsequent research the factors associated with the clients' needs would be studied in terms of the level(s) by which clients' needs depend on these factors. Such a research would further enhance the level of accuracy by which clients' needs can be predicted, assessed or verified.

10.5 Overall summary

The research documented in this communication used some social science concepts as a framework for improving the achievement of construction clients' needs. Firstly the importance of formal decision making was discussed. The selection of the most appropriate decision analysis tool for each aspect of construction is important, as each situation is circumspect. Having identified an analytical tool, the next major thing to do is identify and evaluate the goals (client's needs) with which the different decision options are to be weighed.

Having developed a checklist of clients' needs; adopted a psychometric tool that could evaluate clients' values unto an interval scale; and, identified predominant factors associated with clients' desires (potential predictors), the research has gone a long way towards identifying and evaluating construction clients' needs. Being that numerous decision analysis techniques abound, the evaluated needs can always be used in conjunction with one of these techniques.

The introduction of chapter 1 set out to examine how clients' satisfaction with construction project outcomes can be improved. It was conjectured that clients' needs were improperly defined at project inception, leading to their non-achievement in (some) project schemes. If and only if clients' needs could be accurately defined, then their achievement can be sought with more optimism. The checklist of clients' needs developed in section 8.2.4 and the scaling technique adopted in chapter 2 have paved a way for assessing construction clients' needs as project decision-making criteria more accurately, thus providing a basis for optimising the achievement of clients' needs in project schemes. The research effort has thus yielded fruit by developing a basis for improving the level to which, clients' needs cum satisfaction with project outcomes can be improved. The satisfaction of construction clients cannot be maximised through a single PhD research due to its obvious limitations. However the acceptance and implementation of the recommendations arising from this investigation will ultimately maximise the achievement of clients' needs and thus maximise their satisfaction with project outcomes.

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APPENDICES

APPENDIX A :
FIRST QUESTIONNAIRE

APPENDIX A : FIRST QUESTIONNAIRE

This appendix contains the first questionnaire, which was sent to some selected construction clients. The covering letter used precedes the main questionnaire. The mail merge facility was employed in despatching the questionnaires hence no name or address of recipient is divulged in the following pages.

Covering letter:

(Direct Line: 01902 322108 ; Fax: 01902 322680) Address

«Title» «FirstName» «LastName» Date
«JobTitle»
«Company»
«Address1»
«Address2»
«City» «PostalCode»

Dear «Title» «LastName»,

RECLASSIFICATION OF CONSTRUCTION CLIENTS

The construction industry has acknowledged that its clients are not fully satisfied with its performance. In an attempt to alleviate this shortcoming, the University of Wolverhampton has joined the search for better ways of improving the satisfaction of construction clients. Having achieved success in the modeling of clients' generated risks, the searchlight is now turned on the needs and expectations of construction clients.

Literature reveals that construction clients' needs are diverse and the priority attached to them by different clients varies. Preliminary studies undertaken at our school showed that the descriptions of clients as public, private, commercial and developer clients, etc. are not able to explain the complexities and preference patterns of clients' needs. However, before clients' needs can be fully met, they must be identifiable and well understood. To gain such an understanding, a practical investigation of construction clients' perceptions of their multifarious needs would seem the best approach. Therefore, this research aims at studying construction clients' needs and prospecting on their reclassification on the basis of their communal needs.

To facilitate this research, the cooperation of clients in supplying relevant information towards the investigation is vital. As a first step, we are by this medium sampling the opinions of construction clients regarding the subject. We therefore would welcome your cooperation in completing this accompanying questionnaire. Please note that all information procured in the course of this research will be used for academic purposes only and will not be divulged to any third party. We look forward to hearing from you as soon as possible.

Yours faithfully

Ezekiel A. Chinyio

Encl. : Questionnaire **(NB: The questionnaire now follows in the next six pages).**

DEVELOPMENT OF A NEEDS-BASED TECHNIQUE FOR CLASSIFYING CONSTRUCTION CLIENTS

(A QUESTIONNAIRE FOR CONSTRUCTION CLIENTS)

INTRODUCTION

The research upon which this questionnaire is soliciting information, is aimed at classifying construction clients on the basis of their needs. "Needs" in this case refers to clients' project requirements such as quality of buildings, duration of construction, cost of projects, etc. Literature suggests that while clients' needs are varied, the variation may cluster around client-type or project-type, etc. However, there is no empirical evidence to support these assertions; hence this research.

The questionnaire is divided into three simple and brief sections. Section 1 pertains to general information while section 2 seeks to clarify the different meanings attached to the frequently used terminology on needs and, section 3 investigates the priority attached to identified needs.

It is envisaged that for clients who have undertaken more than one construction project in the past, a conflict of interests might arise with regard to the prioritisation of needs on the different projects because, priorities might vary from project to project. For such clients, the response to this questionnaire should be limited to only one building product/project, preferably the most recent project.

SECTION 1: GENERAL INFORMATION

Your response is in respect of:

Tick Here	
	An individual
	A firm

Number of employees (if a firm)

Tick Here	
	1 - 50
	51 - 500
	Over 500

Average turnover per annum

Tick Here	
	< £50,000
	£50,000 - 100,000
	£100,000 - 1M
	> 1M

How many construction projects have you undertaken within the last five years?

Tick Here	
	1
	2-5
	6-20
	Over 20

What type of building project, do you intend to report in this questionnaire?

Tick Here	
	Office
	Banking/Financial
	Residential
	Academic Institution
	Commercial
	Industrial
	Others (Specify): ____________

Who is the end user of the building?

Tick Here	
	Self
	Rented property
	Others (Specify): ____________

Where is the building located?
(Town/County)

____

What is the average size of the building project being reported for this research?

Number of storeys	
Average floor size	

Are you a property developer?

Tick Here	
	Yes
	No

What sort of development was undertaken for you?

Tick Here	
	New Development
	Refurbishment
	Alterations and Extensions
	Others (specify): ____________

What is the approximate cost of the selected/reported building project?

Tick Here	
	< £50,000
	£50,000 - 100,000
	£100,000 - 1M
	> 1M

When were the reported building works completed?

Tick Here	
	19_ _
	Not yet (On-going)

SECTION 2: DEFINITIONS OF CLIENT NEEDS

Given in the Table below, on the left-hand column, are eight identified needs of construction clients. Each need has been variously defined and the meanings attached to the needs are aggregated in the middle column of the same table. Different clients attach a variety of meanings to the needs. Some of the meanings are applicable to clients in accordance with their particular requirements. As a construction client, tick (in the indicated third column) any of the alternative meanings that are applicable to you in respect of the project being reported and, specify any other meaning(s) which is/are relevant to you but has/have not been highlighted.

Identified Needs	**Alternative Meanings**	**Tick here if a meaning is applicable to you**
Aesthetics	Beautiful looking product	
	Beautiful interior	
	Beautiful exterior	
	Beautiful finishes/decorations	
	Are there other meanings you attach to aesthetics, which have not been listed above? If there are, please specify them here below.	
Economy	Lowest price whatsoever	
	Price of the product to meet a given budget	
	Reducing tendering costs by inviting few bidders	
	Balance between capital and maintenance (or life cycle) costs	
	Maximising taxation benefits	
	Indication of a firm price with minimal variations	
	Are there other ways in which you perceive economy which have not been listed above? If there are, please specify them here below.	
Functionality	Building to be operationally efficient with its intended purpose	
	Durable building	
	Keeping existing buildings operational during construction	
	Are there other meanings you attach to functionality which have not been listed above? If yes, please specify them here below.	

(SPECIFICATION/MEANINGS OF NEEDS CONTINUED)

Need	Meanings (as before)	Tick here (as before)
Quality	Quality of the product to match current standards	
	Innovative design incorporating high/latest technology	
	The Building to reflect your activities and image	
	Value for money i.e., desired quality at appropriate price	
	Are there other meanings you attach to the need of quality which have not been listed above? If yes, please specify them here below.	
Working Relationships	Avoidance of disputes	
	Familiarity with contractor	
	Desire to be actively involved in your project(s)	
	Desire to be kept informed about the project throughout its life	
	Non-confrontational relationship with the contractor	
	Probity (Internal and Public accountability)	
	Are there other meanings you attach to the need for better working relationships which have not been listed above? If yes, please specify them here below.	
Safety	Minimal exposure to risk for the client	
	Recognition of risks associated with the project	
	Do you have other meanings attached to safety which have not been listed above? If you do, please specify them here below.	
Surprises (I.e. Lack of :)	Clear allocation of responsibilities between you and contractor	
	Flexibility to change the design during construction	
	Avoidance of claims	
	Guarantees of, and on construction	
	Which other sort of surprises are you prone to which have not been listed above? Please specify them here below.	

(SPECIFICATION/MEANINGS OF NEEDS CONTINUED)

Need	**Meanings (as before)**	**Tick here (as before)**
Time	Timely construction (i.e. being on schedule)	
	Securing timely planning approvals	
	High speed of design and construction	
	Early start	
	Minimal interference	
	Is there an aspect of time you desire which has not been listed above? Please specify such here below.	

Are there other needs (and meanings thereof) known to you which have not been listed above? If yes, please state them in the following table.

Need	Meaning(s)	Tick if applicable to you
NB: Continue on a separate page where necessary		

SECTION 3: THE PREFERENCES OF YOUR NEEDS

The relative importance of your needs as a construction client can be ascertained by a knowledge of their relative preference with respect to each other. The eight needs of Section 1 are thus paired with one another so as to provide a basis for ascertaining their differential priorities. Based on your definition of the needs in Section 2, indicate by ticking which need between each pair, is most preferred by you. The first three entries of the table are examples of how the table should be completed. For these first three entries, the person who has ticked prefers multi-storey buildings to single-storeys. Similarly, he/she prefers modern buildings as located within a town as against countryside buildings of prehistoric outlook.

(AN EXAMPLE) Which amongst these pair-comparisons do you prefer? **(To make your choice;)**				
	Tick here for attribute on the left	**and**	Tick here for attribute on the right	
Single-storey building		OR	✓	Multi-storey building
To build in the town	✓	OR		To build outside town
Modern building	✓	OR		Pre-historic building
Now with respect to your selected building project's needs, which amongst the following pairs of needs do you prefer most? (Tick your preferences in either the 2nd or 4th column as in the example above)				
Economy		OR		Time
Working Relations		OR		Safety
Lack of Surprises		OR		Functionality
Aesthetics		OR		Economy
Quality		OR		Time
Functionality		OR		Working Relations
Aesthetics		OR		Lack of Surprises
Economy		OR		Quality
Time		OR		Safety
Working Relations		OR		Aesthetics
Lack of Surprises		OR		Economy
Safety		OR		Quality
(NB: Pair comparisons continued on the next page)				

(Preference choice between pairs of needs continued) Which need do you prefer most?				
Functionality		OR		Time
Lack of Surprises		OR		Working Relations
Economy		OR		Safety
Quality		OR		Functionality
Time		OR		Aesthetics
Working Relations		OR		Economy
Functionality		OR		Safety
Aesthetics		OR		Quality
Lack of Surprises		OR		Time
Economy		OR		Functionality
Safety		OR		Aesthetics
Quality		OR		Lack of Surprises
Time		OR		Working Relations
Functionality		OR		Aesthetics
Safety		OR		Lack of Surprises
Quality		OR		Working Relations

Please supply the following information

Respondent's Name	
Designation (If applicable)	
Address	
Telephone Number	

Would you like us to send you a report of the outcome of this survey?

Tick Here	
	Yes
	No

Would you like to participate in the second and more comprehensive stage of this research?

Tick Here	
	Yes
	No

The Research team is very grateful to you for participating in this investigation.

Please return completed questionnaire to:

E. A. Chinyio
School of Construction, Engineering & Technology
(Room MA166)
University of Wolverhampton
Wulfruna Street
Wolverhampton WV1 1SB, UK
Tel: (01902 322108); Fax: (10902 322680)

APPENDIX B :
PILOT SURVEY OF FIRST QUESTIONNAIRE

APPENDIX B : PILOT SURVEY OF FIRST QUESTIONNAIRE

Explicit opinion offered by an expert on the first questionnaire

The following pages show the opinion of an expert on the compilation of the first questionnaire. As indicated in the main report, this opinion comes from a major property developer based in the West Midlands. In compliance with the agreement between the researcher and the respondent, the identity of the respondent is not divulged.

DEVELOPMENT OF A NEEDS-BASED TECHNIQUE FOR CLASSIFYING CONSTRUCTION CLIENTS

(A QUESTIONNAIRE FOR CONSTRUCTION CLIENTS)

INTRODUCTION

The research upon which this questionnaire is soliciting information is aimed at classifying construction clients on the basis of their communal needs. "Needs" in this case refers to clients' project requirements such as quality of buildings, duration of construction, cost of projects, etc. Literature suggests that while clients' needs are varied, the variation may cluster around client-type or project-type, etc. However, there is no empirical evidence to support these assertions; hence this research.

The questionnaire is divided into three simple and brief sections. Section 1 pertains to general information while section 2 seeks to clarify the different meanings attached to the frequently used terminology on needs and, section 3 basically investigates the priority attached to identified needs.

It is envisaged that for clients who have undertaken more than one construction project in the past, a conflict of interests might arise with regard to the prioritisation of needs on the different projects because, priorities might vary from project to project. For such clients, **the response to this questionnaire should be limited to only one building product/project preferably a recent project.**

SECTION 1: GENERAL INFORMATION

Your response is in respect of:

Tick Here	
	An individual
✓	A firm

Number of employees (if a firm)

Tick Here	
✓	1 - 50
	51 - 500
	Over 500

Average turnover per annum

Tick Here	
	< £50,000
	£50,000 - 1M
✓	> 1M

How many construction projects have you ever undertaken?

Tick Here	
	1
	2-5
✓	6-20
	Over 20

(GENERAL INFORMATION CONTINUED)

What type of building project do you intend to report in this questionnaire?

Tick Here	
	Office
	Banking/Financial
	Residential
	Academic Institution
✓	Commercial
	Industrial
	Others (Specify): ______________

Who is the end user of the building?

Tick Here	
	Self
✓	Rented property
	Others (Specify): ______________

Where is the building located?
(Town/District) ~~[illegible]~~ WEAKEFIELD

What sort of development was undertaken for you?

Tick Here	
✓	New Development
	Refurbishment
	Alterations and Extensions
	Others (specify): ______________

What is the approximate cost of the selected/reported building project?

Tick Here	
	< £50,000
	£50,000 - 1M
✓	> 1M

What is the average size of the building project being reported for this research?

Number of storeys	1
Average floor size	50,000 FT²

When were the reported building-works completed?

Tick Here	
✓	1993
	Not yet (On-going)

Are you a property developer?

Tick Here	
✓	Yes
	No

SECTION 2: DEFINITIONS OF CLIENT NEEDS

Given in the Table below, on the left hand column, are eight needs of construction clients as identified in literature. Each need has been variously defined by different authors and the meanings attached to the needs are aggregated in the middle column of the same table. Different clients attach a variety of meanings to the needs. Some of the meanings are applicable to clients in accordance with their particular requirements. As a construction client, tick (in the indicated third column) the alternative meanings that are applicable to you in respect of the project being reported and, specify any other meaning(s) which is/are relevant to you but has/have not been highlighted.

Identified Needs	Alternative Meanings	Tick here if a meaning is applicable to you
Aesthetics	Beautiful looking product	✓
	Beautiful interior	
	Beautiful exterior	
	Beautiful finishes/decorations	✓
	Are there other meanings you attach to aesthetics which have not been listed above? If there are, please specify them here below. MODERN APPEARANCE SYMPATHETIC TO SURROUNDINGS	
Economy	Lowest price whatsoever	
	Price of the product to meet a given budget	✓
	Reducing tendering costs by inviting few bidders	
	Balance between capital and maintenance (or life cycle) costs	
	Maximising taxation benefits	
	Indication of a firm price with minimal variations	✓
	Are there other ways in which you perceive economy which have not been listed above? If there are, please specify them here below. VALUE FOR MONEY	
Functionality	Building to be operationally efficient with its intended purpose	✓
	Durable building	✓
	Keeping existing buildings operational during construction	
	Are there other meanings you attach to functionality which have not been listed above? If yes, please specify them here below. LOW MAINTENANCE.	
Quality	Quality of the product to match current standards	
	Innovative design incorporating high/latest technology	
	The Building to reflect your activities and image	✓
	Value for money i.e., desired quality at appropriate price	✓
	Are there other meanings you attach to the need of quality which have not been listed above? If yes, please specify them here below.	

(SPECIFICATION/MEANINGS OF NEEDS CONTINUED)

Need	**Meanings (as before)**	**Tick here (as before)**
Working Relationships	Avoidance of disputes	✓
	Familiarity with contractor	✓
	Desire to be actively involved in your project(s)	✓
	Desire to be kept informed about the project throughout its life	✓
	Non-confrontational relationship with the contractor	✓
	Probity (Internal and Public accountability)	
	Are there other meanings you attach to the need for better working relationships which have not been listed above? If yes, please specify them here below.	
Safety	Minimal exposure to risk for the client	✓
	Recognition of risks associated with the project	✓
	Do you have other meanings attached to safety which have not been listed above? If you do, please specify them here below.	
Surprises (I.e. Lack of :)	Clear allocation of responsibilities between you and contractor	✓
	Flexibility to change the design during construction	✓
	Avoidance of claims	✓
	Guarantees of, and on construction	✓
	Which other sort of surprises are you prone to which have not been listed above? Please specify them here below.	
Time	Timely construction (i.e. being on schedule)	✓
	Securing timely planning approvals	✓
	High speed of design and construction	✓
	Early start	✓
	Minimal interference	✓
	Is there an aspect of time you desire which has not been listed above? Please specify such here below.	

SECTION 3: THE PREFERENCES OF YOUR NEEDS

The relative importance of your needs can be ascertained by a knowledge of their relative preference with respect to each other. The eight needs of Section 1 are thus paired with one another so as to provide a basis for ascertaining their differential priorities. Based on your definition of the needs in Section 2, indicate by ticking which need between each pair, is most preferred by you. The first three entries of the table are examples of how the table should be completed. For these first three entries, the person who has ticked prefers multi-storey buildings to single-storeys. Similarly, he/she prefers modern buildings as located within a town as against countryside buildings of prehistoric outlook.

Which amongst these pair-comparisons do you prefer? **(EXAMPLES)**				
	Tick Here	OR	Tick Here	
Single-storey building		OR	✓	Multi-storey building
To build in the town	✓	OR		To build outside town
Modern building	✓	OR		Pre-historic building
Now with respect to your selected building project's needs, which amongst the following pairs of needs do you prefer most? *(Tick your preference either in the 2nd or 4th column as in the example)*				
Economy	✓	OR		Time
Working Relations	✓	OR		Safety
Lack of Surprises		OR	✓	Functionality
Aesthetics	✓	OR		Economy
Quality	✓	OR		Time
Functionality	✓	OR		Working Relations
Aesthetics	✓	OR		Lack of Surprises
Economy		OR	✓	Quality
Time		OR	✓	Safety
Working Relations	✓	OR		Aesthetics
Lack of Surprises	✓	OR		Economy
Safety		OR	✓	Quality
Functionality	✓	OR		Time
Lack of Surprises		OR	✓	Working Relations
Economy		OR	✓	Safety
Quality	✓	OR		Functionality
Time		OR	✓	Aesthetics
Working Relations	✓	OR		Economy
Functionality	✓	OR		Safety
Aesthetics	✓	OR		Quality
Lack of Surprises	✓	OR		Time

(Choice of preference between pairs of needs continued) Which need do you prefer most?				
Economy		OR	✓	Functionality
Safety		OR	✓	Aesthetics
Quality	✓	OR		Lack of Surprises
Time		OR	✓	Working Relations
Functionality		OR	✓	Aesthetics
Safety		OR	✓	Lack of Surprises
Quality	✓	OR		Working Relations

Would you like us to send you a report of the outcome of this survey?

Tick Here	
✓	Yes
	No

If yes, please supply the following information

Respondent's Name	A
Designation (If applicable)	Fi
Address	B Ba Alfrick, Worcester WR6 5HF
Telephone Number	01886 884511

Would you like to participate in the second and more comprehensive stage of this research?

Tick Here	
✓	Yes
	No

The Research team is very grateful to you for participating in this investigation.

Send your reply/correspondence in respect of this questionnaire to:
E. A. Chinyio
School of Construction, Engineering & Technology (Room MA166)
University of Wolverhampton
Wulfruna Street
Wolverhampton WV1 1SB, UK
Tel: (01902 322108); Fax: (10902 322680)

APPENDIX C :
PREFERENCE RATING OF NEEDS BY CONSTRUCTION CLIENTS

APPENDIX C : PREFERENCE RATING OF NEEDS BY CONSTRUCTION CLIENTS

Introduction

Through Section-C of the first questionnaire, the surveyed clients were able to indicate preference ratings of eight needs. The aggregate score of each client was built up by assigning a value of one to each preference score. In the end, one was added to all scores to eliminate the zeros. So the ratings shown here are equivalent to ranks. A score of 8 denotes the need that was scored most while 1 indicates that the need was not preffered over any other need at all.

The following abbreviations are used:
Name = The designation assigned to respondent to maintain confidentiality;
Aes. = Aesthetics;
Econ. = Economy;
Qual. = Quality;
Rela. = Relations; and,
Com. = Commitment (i,e., lack of surprises)

The rating of needs by the clients now follows:

Name	Aes.	Econ	Func.	Qual.	Rela.	Safety	Com.	Time
C2	6	5	2	8	3	7	1	4
C3	6	2	5	8	7	3	4	1
C4	6	5	2	7	1	8	3	4
C5	1	3	6	8	2	7	5	4
C6	3	1	7	6	5	2	8	4
C7	1	7	8	5	2	3	4	1
C8	6	3	5	8	1	7	4	2
C9	5	1	7	6	3	8	4	2
C10	4	3	6	7	2	8	5	1
C11	8	2	6	7	5	3	4	1
C12	2	6	5	4	1	8	3	7
C13	1	5	2	7	8	6	4	3
C14	5	3	7	6	2	8	4	1
C15	4	3	5	6	2	8	1	7
C16	6	2	3	7	4	8	5	1
C17	7	5	3	8	6	4	2	1
C18	4	7	6	5	3	8	2	1
C19	4	1	5	7	6	8	2	3
C21	3	2	6	4	5	8	7	1
C22	3	4	8	6	2	7	5	1
C23	2	4	8	6	3	7	1	5
C24	1	3	6	5	4	2	7	8

Name	Aes.	Econ	Func.	Qual.	Rela.	Safety	Com.	Time
C25	6	4	5	8	1	7	3	2
C26	5	3	6	6	2	6	1	4
C27	6	4	5	7	1	8	3	2
C28	6	4	5	7	3	8	1	2
C29	7	4	7	4	1	7	4	2
C30	4	5	7	6	3	8	1	2
C31	1	5	6	8	4	2	7	3
C32	4	6	7	5	1	8	2	3
C33	7	5	8	6	3	2	1	4
C34	1	4	6	2	8	6	3	7
C35	3	5	7	4	1	8	6	2
C36	3	4	5	7	2	8	6	1
C37	3	1	6	8	7	4	2	5
C38	6	3	7	5	1	2	8	4
C39	2	5	6	8	1	7	3	4
C40	4	5	7	6	2	8	1	3
C41	8	4	6	7	1	4	4	2
C42	7	2	5	8	6	4	1	3
C44	3	5	8	7	4	6	2	1
C46	2	1	7	6	5	8	4	3
C47	1	8	4	7	2	6	4	4
C49	1	5	6	7	2	8	4	3
C50	1	5	6	7	3	8	2	4
C51	2	6	7	8	1	4	5	3
C52	1	5	7	6	3	8	2	4
C53	7	4	8	6	3	2	5	1
C55	4	5	8	6	3	7	2	1
C57	4	5	6	7	1	8	3	2
C58	1	7	6	8	4	3	2	5
C59	5	3	5	8	2	5	7	1
C60	1	6	5	3	2	8	7	4
C61	1	3	2	7	4	5	8	6
C62	3	2	6	8	5	4	7	1
C63	4	5	6	7	1	8	3	2
C64	3	4	2	7	6	8	1	5
C65	4	6	7	4	4	8	1	5
C66	1	8	5	4	2	7	3	6
C67	6	4	7	5	1	8	3	2
C69	2	5	8	7	1	4	3	6
C70	1	5	7	6	4	8	2	3
C71	3	7	4	6	5	2	1	8
C72	7	5	4	8	3	2	6	1
C73	4	5	3	1	6	2	8	2
C74	1	8	6	7	4	5	3	2
C75	6	4	8	3	5	7	2	1
C76	1	3	8	6	4	7	5	2
C78	6	7	1	8	3	4	2	5

Name	Aes.	Econ	Func.	Qual.	Rela.	Safety	Com.	Time
C79	1	3	7	5	2	8	6	4
C80	6	3	4	7	2	8	5	1
C81	5	6	1	4	7	8	3	2
C82	2	4	5	6	7	8	3	1
C83	4	1	8	3	7	5	6	2
C84	4	5	7	6	2	8	1	3
C85	1	6	4	2	7	8	5	3
C86	2	8	5	6	1	7	3	4
C87	1	5	6	4	2	8	7	3
C89	4	3	8	2	6	7	5	1
C90	2	7	8	6	3	4	1	5
C91	1	4	5	6	7	8	2	3
C92	2	4	6	7	1	8	5	3
C93	2	6	3	7	4	8	1	5
C94	1	3	8	2	6	6	6	4
C95	6	4	7	8	5	2	3	1
C96	1	2	8	4	6	7	3	5
C97	3	1	5	8	2	7	6	4
C98	1	6	7	2	5	8	3	4
C99	5	3	1	8	7	4	6	2
C102	5	7	4	6	2	1	8	3
C103	1	4	5	7	2	8	6	3
C104	1	5	8	7	5	5	3	2
C106	1	7	4	5	3	8	6	2
C107	6	5	3	7	2	4	1	8
C108	2	7	6	8	1	5	3	4
C109	5	4	7	6	1	8	3	2
C110	1	7	3	8	5	4	6	2
C112	1	6	4	7	8	2	5	3
C113	1	6	8	7	2	4	2	5
C115	2	1	4	6	3	8	5	7
C116	7	4	3	6	5	8	1	2
C117	5	7	4	6	1	8	2	3
C118	3	4	7	6	1	8	2	5
C119	3	1	2	5	8	7	6	6
C120	1	2	4	7	6	8	4	4
C121	8	5	3	7	2	6	1	4
C122	7	3	5	2	4	1	7	2
C123	4	3	6	7	2	8	1	5
C124	8	6	3	7	5	2	4	1
C125	1	5	7	6	2	8	4	3
C126	2	6	7	5	3	1	8	4
C128	2	6	6	8	1	6	3	4
C129	1	7	3	4	2	5	7	7
C130	3	2	8	6	5	7	4	1
C132	1	3	5	7	4	8	6	2

APPENDIX D :
SECOND QUESTIONNAIRE

APPENDIX D : SECOND QUESTIONNAIRE

The following pages contain the specimen of the second questionnaire, which was sent to some selected members of G1 and G2. The covering letters were typed on letterheaded paper, bearing the address of the 'School of Engineering & The Built Environment, University of Wolverhampton'. The mail-merge facility was used to speed the preparation of questionnaires for individual clients. For confidential reasons the names and addresses of recipients are not included with this sample questionnaire. Each complete questionnaire was dated in accordance with the day in which it was posted.

Covering letter:

(Direct Line: 01902 322108; Email: A.E.Chinyio@wlv.ac.uk)

Letterhead

Date

Our ref.: «Refcode»

«Title» «FirstName» «LastName»
«Designation»
«Company»
«Address1»
«Address2»
«Address3»
«City» «PostalCode»

Dear «Title» «LastName»,

The classification of construction clients' research project

Using the data supplied by clients of the construction industry, we have been able to classify clients into four needs-based groups. Our findings indicate that the priorities attached to construction needs by these four client groups differ principally on some variables which we have identified but cannot yet divulge as they are yet to be validated.

We are now at the validation phase of the research and would appreciate your continued assistance by completing the enclosed questionnaire. Essentially, we are asking you to identify, from a short checklist, predominant factors, which underpin the prioritisation of your needs in construction projects. Your expert knowledge and experience in identifying these factors will assist us validate the prioritised variables from our first survey.

We count on your co-operation in supplying the requested information to bring this study to a successful conclusion. we thus look forward to receiving your completed questionnaire as soon as possible.

Yours faithfully

Ezekiel A. Chinyio
(For the research Team)

NB: The second questionnaire now follows.

FACTORS UNDERPINNING THE PRIORITISATION OF CONSTRUCTION PROJECT NEEDS BY CLIENTS

REF: («REFCODE»)

This follow-up questionnaire seeks to study the factors, which underpin levels of desire for construction project needs and how they vary between different clients. Towards this end a preliminary list of potential attributes has been compiled and is presented in the first column of the following Table. These attributes are not listed in any order. Please tick (✓) the level, which the listed attributes influence your desires for the 8 generic needs of: aesthetics, economy, function, quality, relations, safety, lack of surprises and time. A blank format is provided on the next page for you to specify other relevant attributes, which may be missing in our compilation.

Table: Checklist of potential factors influencing construction clients' needs

Example:	*Level of influence*					
To what extent do the following factors influence your prioritisation of project needs?	*None (0%)*	*1-20%*	*21-40%*	*41-60%*	*61-80%*	*81-100%*
1) Amount of outside view the building occupants can have				✔		
2) Average age of the users of the building facility		✔				
(End of example)						

Following the example above please provide answers by ticking the appropriate column						
What amount of influence do the following factors have on your prioritisation of construction projects' needs?	**Level of influence in percentage**					
	None (0%)	**1-20%**	**21-40%**	**41-60%**	**61-80%**	**81-100%**
1) Your organisational identity						
2) Your business function						
3) Size of your organisation						
4) Number of your employees						
5) Status of employees						
6) Type of facility to be built						
7) Type of development: new or refurbishment						
8) Size of building(s)						
9) Type of clients/customers						
10) Expressed desires of clients/customers						
11) Public opinion concerning building product/materials						
12) Public perception of your organisation						
13) Needs of other users of the facility						
14) Special users' (e.g. disabled, etc.) needs						
15) Specifications of consultants						
16) Advise of in-house professionals						
17) Planning regulations						
18) Building regulations						
19) Competition with rivals						
20) Personal taste of company owners/directors						
21) Personal taste of a designated project officer						
22)) Aggregated taste of management staff						
23) Aggregated taste of company employees						

«Refcode»

Any other attributes:

What additional attributes other than those listed above influence your prioritisation of projects needs?

	Level of influence in percentage				
Attributes	**1-20%**	**21-40%**	**41-60%**	**61-80%**	**81-100%**

(NB: More attributes can be listed on a fresh page)

<u>Please return completed questionnaire to:</u>
E.A.Chinyio
(Room MA166)
School of Engineering and The Built Environment
University of Wolverhampton
Wulfruna Street
Wolverhampton WV1 1SB

APPENDIX E :
PILOT SURVEY OF SECOND QUESTIONNAIRE

APPENDIX E : PILOT SURVEY OF SECOND QUESTIONNAIRE

Explicit opinion offered by an expert on the second questionnaire

The following pages show the opinion of an expert on the compilation of the second questionnaire. As indicated in the main report, this opinion comes from a Nationally renown Insurance Company. In compliance with the agreement between the researcher and the respondent, the identity of the respondent is not divulged.

FACTORS UNDERPINNING THE PRIORITISATION OF CONSTRUCTION PROJECT NEEDS BY CLIENTS

This questionnaire seeks to ascertain the current factors which underpin the prioritisation of project needs by construction clients. Towards this end a preliminary list of potential factors has been compiled and is presented in the first column of the Table below. (The factors are not listed in any order). Please tick (✓) the level by which the listed factors influence your differential desires for the 8 generic needs of: aesthetics, economy, function, quality, relations, safety, lack of surprises and time. A more detail definition of these 8 needs is provided in the Appendix. A blank format is also provided for you to specify other relevant factors which may be missing in our compilations. **Please note that any information supplied and identity of persons indicated shall be held in strict confidence.**

Table: Checklist of potential factors influencing construction clients' needs

Example: *To what extent do the following factors influence your prioritisation of project needs?*	*Level of influence* None (0%)	*1-20%*	*21-40%*	*41-60%*	*61-80%*	*81-100%*
1) Amount of outside view the building occupants can have				✓		
2) Average age of the users of the building facility		✓				

(End of example)

WE DEVELOP FOR 3rd Parties

Following the example above please provide answers by ticking the appropriate column

What amount of influence do the following factors have on your prioritisation of construction project needs?	**Level of influence in percentage** None (0%)	**1-20%**	**21-40%**	**41-60%**	**61-80%**	**81-100%**
1) Your organisational identity		✓				
2) Your business function	✓					
3) Size of your organisation	✓					
4) Number of your employees	✓					
5) Status of employees	✓					
6) Type of facility to be built						✓
7) Type of development: new or refurbishment						✓
8) Size of building(s)						✓
9) Type of clients/customers						✓
10) Expressed desires of clients/customers						✓
11) Public opinion concerning building product/materials		✓				
12) Public perception of your organisation					✓	
13) Needs of other users of the facility						✓
14) Special users' (e.g. disabled, etc.) needs					✓	
15) Specifications of consultants To a defined brief set by client						✓
16) Advise of in-house professionals						✓
17) Planning regulations						✓
18) Building regulations		✓			✓	
19) Competition with rivals		✓				
20) Personal taste of company owners/directors		✓				
21) Personal taste of a designated project officer		✓				
22)) Aggregated taste of management staff		✓				
23) Aggregated taste of company employees	✓					

End of checklist

Any other factors:

What additional factors other than those listed above influence your prioritisation of construction projects' needs?

	Level of influence in percentage				
Factors	**1-20%**	**21-40%**	**41-60%**	**61-80%**	**81-100%**
Production of a Development Brief and sign off by Project Team					✓
Audit pre contract Consultant design					✓
Surveys & Investigation prior to developing design					✓
Define all consents & other legal documents required to implement					
project using risk register which is monitored pre & post					
contract to ensure ~~[illegible]~~ project design & construction is					✓
developed in a timely way and the appropriate					
~~agreements and~~ consents obtained at the appropriate time					

Please comment freely, by means of criticising the research or the questionnaire thereof, or by suggesting how our endeavours could better be achieved.
Suggest the questionnaire needs to be constructed to reflect the stages in the development of construction projects.

Name of Respondent:	TREVOR MITCHELL
Name of Organisation	ROYAL & SUN ALLIANCE PROPERTY INVESTMENTS
Designation/Post	DEVELOPMENT & BUILDING SURVEYOR
Telephone No.	0171 826 12[illegible]1
Are you interested in the findings of the research? Please tick: YES (✓) NO ( )	

Thank you very much for supporting our research by completing the questionnaire.

Please return completed questionnaire to:
E.A.Chinyio
(Room MA166)
School of Engineering and The Built Environment
University of Wolverhampton
Wulfruna Street
Wolverhampton WV1 1SB

APPENDIX

Definition of 8 generic construction project needs

Main Need	Differential meanings
Aesthetics	1) Beautiful looking product 2) Prestigious building
Economy	1) Lowest price 2) Price of the product to meet the budget 3) Reducing tendering costs by inviting few bidders. 4) Balance between capital and life cycle costs 5) Maximising taxation benefits 6) Indication of firm price with minimal variations
Function-ality	1) Building to be efficient with intended purpose 2) Durable building 3) Keep existing buildings operational during construction
Quality	1) Quality of the product to match current standards 2) Innovative design incorporating high/latest technology 3) The building should reflect the client's activities and image 4) Value for money i.e., desired quality at appropriate price
Relations	1) Avoidance of disputes 2) Familiarity with contractor 3) Desire to be actively involved and kept informed about the project throughout its life 4) Non-confrontational relationship with the contractor 5) Internal and Public accountability
Safety	1) Minimal exposure to risk for the client 2) Recognition of risks and uncertainty associated with the project
Commitment (i.e Lack of Surprises)	1) Clear allocation of responsibilities 3) Flexibility to change the design (even) during the construction phase 3) Avoidance of claims 4) Guarantees on construction/products
Time	1) Timely construction 2) Securing timely approvals 3) High speed of design cum construction 4) Early start 5) Minimal interference with the works

NB: The word 'Appendix' at the top of this page indicates the attachment that was given to the respondents to refresh their memories on the previous definitions of needs

APPENDIX F:
COMPUTER PROGRAMME

APPENDIX F : COMPUTER PROGRAMME

(Programme written in SQL to identify inconsistent preferences made by construction clients)

Section A
(This section shows the net programme).

Start of programme:

```
data prefs;
  length subject 4 p $2;
  subject + 1;
  infile cards missover;
  do until (p=''); input p @; if p~='' and p~='-' then output; end;
  cards;
ab ac ad bc bd cd
ab ac da bc bd cd
ab ca ad bc bd cd
ab ca  - bc bd cd
ab  - ad bc bd cd
run;

data vars;
  infile 'vars.csv' firstobs=2;
  input pair $2.;
run;

proc transpose data=vars out=vars (drop=_name_);
  var pair;
run;

data prefs;
  infile 'prefs1.csv' dsd firstobs=2 stopover;
  input client et rs zf ae qt fr az eq ts ra ze sq ft zr es qf ta re fs aq zt ef sa qz tr fa sz qr;
run;

data prefs;
  if (_n_=1) then set vars;
  set prefs;
  array pair{*} col1-col28;
  array pref{*} et--qr;
  do i = 1 to 28;
```

(Continuation of programme)

```
select (pref{i});
     when (0) p = ' ';
     when (1) p = pair{i};
     when (2) p = reverse(pair{i});
     otherwise do;
      p = ' ';
      put client= pair{i} pref{i};
      end;
      end;
      if (p~='') then output;
      end;
      keep client p;
      run;
```

End of programme.

Section B
(This section shows the set of instructions used to run the programme).

Start of instructions:

```
title1 "%sysget(PWD) %scan(%sysget(SAS_ARGS),1)";

%inc prefs3;

data prefs;
  set prefs;
  length c1 c2 $1;
  i + 1;
  c1=substr(p,1,1); c2=substr(p,2,1);
  drop p;
run;

/*-----------------------------------------------------------------------*/
title2 'Locate conflicting triads';

options nocenter;

proc sql;
  create table conflict as
  select p1.client, p1.c1, p1.c2, p2.c2 as c3, p3.c2 as c4
  from prefs as p1, prefs as p2, prefs as p3
  where p2.client=p1.client and p2.c1=p1.c2
    and p3.client=p2.client and p3.c1=p2.c2
    and p3.c2=p1.c1;
```

(Instructions continued)

```
/* Now just simplify the output by eliminating multiple observations
   which merely express the same set of choices...
*/

data conflict; set conflict; keep client i p; i + 1;
  p = c1 || c2; output; p = c2 || c3; output; p = c3 || c4; output;
run;

proc sort data=conflict; by client i p; run;

proc transpose data=conflict out=conflict (drop=_name_) prefix=p;
  var p; by client i;
run;

proc sort data=conflict nodupkey; by client p1-p3; run;

proc report data=conflict;
  column client p1-p3;
  define client / group;
  break before client / skip;
run;

/*-----------------------------------------------------------------*/
title2 'Print ranking of choices';

/* Create data set c with one var per choice ...*/
proc transpose data=prefs out=c (rename=(col1=c)); var c1 c2; by i; run;
proc summary data=c nway; class c; output out=c (keep=c); run;
proc transpose data=c out=c (drop=_name_); id c; run;

proc summary data=prefs nway; class client c1; output out=rank; run;

proc transpose data=rank out=rank1 (drop=_name_);
  by client; id c1; var _freq_;
run;

data rank1; set c rank1; run;

proc transpose data=rank1 out=rank1 (rename=(col1=votes)); by client; run;
data rank1; set rank1; if (votes=.) then votes = 0; run;
proc sort data=rank1 out=rank2; by client descending votes; run;

proc summary data=rank1 nway;
  class client; var votes; output out=votes sum=;
run;
data rank1;
```

(Instructions continued)

```
 set rank1 votes; by client; if (_name_='') then _name_='votes';
run;

proc transpose data=rank1 out=rank1 (drop=_name_); var votes; by client; run;

data rank2;
 set rank2;
 by client descending votes;
 length pref $20;
 if (first.client) then pref = '';
 if (first.votes and not last.votes) then pref = trim(pref) || '(';
 pref = trim(pref) || _name_;
 if (last.votes and not first.votes) then pref = trim(pref) || ')';
 if last.client;
 pref = lowcase(pref);
 keep client pref;
 retain pref;
run;

proc summary data=conflict nway;
 class client;
 output out=triads (keep=client _freq_ rename=(_freq_=triads));
run;

data rank;
 merge rank2 rank1 triads;
 by client;
 if (triads=.) then triads = 0;
run;

proc print data=rank;
run;

proc freq data=rank;
 tables votes triads;
run;

proc tabulate data=rank format=5.;
 class votes triads;
 table votes all, triads all;
run;

%csv(rank,'rank.csv');
```

End of instructions.

APPENDIX G:
OUTPUT OF SAS PROGRAMME

APPENDIX G
OUTPUT OF SAS PROGRAMME WITH RESPECT TO INTRANSITIVE CHOICES MADE BY CONSTRUCTION CLIENTS

Section A

The following section shows the intransitive choices made by the clients. Symbols have been used to represent the eight needs as follows: a = aesthetics; e = economy; f = function; q = quality; r = relations; s =safety; z = no-surprises; and, t = time.

Each row in the following output represents a circular triad. For example, for client Number 1, the first row of his/her data shows a circular triad in respect of aesthetics + economy + safety (shown as: ae   es   sa). The numbers 1,2,3,... under the column designated as 'client' denotes the numbers by which the clients were code-named.

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
1
Locate conflicting triads

      CLIENT  P1   P2   P3

           1  ae   es   sa
              ae   ez   za
              at   fa   tf
              es   fe   sf
              es   st   te
              ez   te   zt
              fq   qs   sf
              fq   qt   tf
              fz   tf   zt

           2  ae   er   ra
              at   ra   tr

           4  ae   ef   fa
              at   fa   tf
              az   fa   zf

           6  ae   es   sa
              aq   fa   qf
              aq   qr   ra
              aq   qs   sa
              aq   qt   ta
              fz   qf   zq
```

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
2
Locate conflicting triads

      CLIENT  P1   P2   P3
           8  at   fa   tf
              az   qa   zq
              et   fe   tf
              fz   qf   zq
              fz   tf   zt
              qs   sz   zq

           9  az   ra   zr

          11  af   fr   ra
              aq   qr   ra

          12  ef   fq   qe

          13  ez   qe   zq
              fz   qf   zq
              fz   tf   zt
              qs   sz   zq

          14  er   rz   ze

          17  af   fq   qa
              ef   fq   qe
              es   re   sr
              fq   qr   rf
              fq   qs   sf
              fz   sf   zs
              rz   sr   zs

          20  ar   fa   rf

          21  et   fe   tf
              fq   qt   tf
              fr   rt   tf
              fz   tf   zt

          23  et   re   tr
              et   se   ts
              qt   sq   ts

          24  es   qe   sq
              qr   rs   sq

          26  fq   qs   sf
```

/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
3
Locate conflicting triads

CLIENT	P1	P2	P3
29	as	fa	sf
	eq	qz	ze
31	er	rt	te
	ez	fe	zf
	ez	te	zt
34	ez	fe	zf
	fq	qz	zf
	ft	tz	zf
36	ez	fe	zf
37	az	sa	zs
	ft	sf	ts
	fz	sf	zs
38	at	tz	za
	ft	tz	zf
	qt	tz	zq
39	ae	ef	fa
	ae	et	ta
	ae	ez	za
	ef	fq	qe
	fq	qs	sf
41	ez	se	zs
43	ae	et	ta
	ae	ez	za
	ar	rs	sa
	ar	rt	ta
	ar	rz	za
	er	rs	se
	et	se	ts
	qr	rs	sq
	qt	sq	ts
44	ae	er	ra
	ae	es	sa
	es	fe	sf

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
4
Locate conflicting triads

     CLIENT  P1   P2   P3

         44  fq   qs   sf


         45  fq   qs   sf

         47  ft   tz   zf

         50  er   rz   ze
             et   tz   ze

         51  ar   rs   sa
             er   rs   se
             ez   se   zs
             rs   st   tr

         52  er   rz   ze
             et   tz   ze

         53  az   fa   zf
             er   rs   se
             ez   fe   zf
             ez   se   zs
             fq   qz   zf

         54  at   sa   ts
             az   ea   ze
             az   fa   zf
             az   ra   zr
             er   qe   rq
             er   rs   se
             et   se   ts
             et   tz   ze
             fr   qf   rq
             fs   sz   zf
             ft   tz   zf
             qz   rq   zr
             rs   sz   zr
             rt   tz   zr
```

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
5
Locate conflicting triads

     CLIENT  P1  P2  P3

         56  at  ra  tr
             az  ea  ze
             az  qa  zq
             az  sa  zs
             ef  fz  ze
             er  rz  ze
             ft  rf  tr
             fz  qf  zq
             fz  sf  zs
             qr  rz  zq
             rz  sr  zs
             rz  tr  zt

         59  af  ea  fe
             ar  rs  sa
             at  ea  te
             er  rs  se
             er  rt  te

         61  ae  ef  fa
             ae  er  ra
             er  rt  te
             rt  sr  ts

         62  ae  er  ra
             at  ra  tr
             er  fe  rf
             er  rs  se
             ft  rf  tr
             rs  st  tr

         64  ef  fz  ze
             qt  rq  tr

         65  ar  qa  rq
             az  qa  zq
             qt  rq  tr
             qt  tz  zq

         67  ae  ez  za
             aq  qz  za
```

/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
6
Locate conflicting triads

CLIENT	P1	P2	P3
68	ae	ez	za
	aq	qr	ra
	aq	qz	za
	at	fa	tf
	at	ra	tr
	at	tz	za
	eq	qr	re
	et	fe	tf
	et	re	tr
	ez	fe	zf
	ez	re	zr
	fq	qt	tf
	fq	qz	zf
69	ar	rs	sa
	rs	sz	zr
72	ae	ef	fa
	az	fa	zf
73	ar	rs	sa
	rs	sz	zr
	sz	ts	zt
74	fr	rt	tf
	fs	st	tf
	fz	tf	zt
75	eq	qr	re
	eq	qz	ze
	fr	rs	sf
	qr	rs	sq
75	rs	st	tr
	rs	sz	zr
78	at	ea	te
	es	st	te
	fr	rs	sf
	fr	rz	zf
	rs	st	tr

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sq110
7
Locate conflicting triads

     CLIENT  P1  P2  P3
         80  at  qa  tq
             ft  qf  tq
             fz  rf  zr
             qr  rt  tq
             qz  tq  zt

         83  at  ra  tr

         84  at  ra  tr

         85  ef  fq  qe
             et  qe  tq
             ez  qe  zq

         88  aq  ea  qe
             aq  qs  sa
             ar  fa  rf
             ar  rz  za
             at  ea  te
             at  fa  tf
             at  sa  ts
             at  tz  za
             ef  fq  qe
             ef  fz  ze
             er  rt  te
             er  rz  ze
             es  sz  ze
             fq  qr  rf
             fq  qt  tf
             fs  rf  sr
             qr  rz  zq
             qs  sz  zq
             qt  tz  zq
             rt  sr  ts

         89  es  fe  sf
             es  qe  sq
             es  sz  ze
             et  tz  ze

         90  ar  rs  sa
             ar  rz  za
             at  sa  ts
             at  tz  za
```

```
        /home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
8
Locate conflicting triads

     CLIENT  P1  P2  P3

         91  ae  er  ra
             er  rs  se

         91  er  rz  ze

         94  ar  rt  ta
             az  ta  zt
             ef  fq  qe

         95  ae  ez  za
             ar  fa  rf
             ar  rz  za
             er  fe  rf
             er  rs  se
             ez  se  zs

         96  ar  qa  rq

         97  ar  rz  za
             fr  rz  zf
             rz  tr  zt

         98  qr  rt  tq
             qr  rz  zq

         99  ae  er  ra
             ae  ez  za
             er  rs  se
             ez  se  zs
             qr  rs  sq
             qz  sq  zs
```

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
9
Locate conflicting triads

     CLIENT  P1  P2  P3
        100  ae  es  sa
             at  ra  tr
             at  sa  ts
             az  qa  zq
             az  ra  zr
             es  fe  sf
             es  sz  ze
             et  re  tr
             fq  qs  sf
             fr  rs  sf
             ft  sf  ts
             qs  sz  zq
             rs  sz  zr
             sz  ts  zt

        101  ez  fe  zf
             fq  qz  zf
             fr  rz  zf
             fs  sz  zf
             qr  rs  sq
             qt  sq  ts
             rz  tr  zt
             sz  ts  zt

        104  es  re  sr
             ez  fe  zf
             fq  qz  zf

        104  fr  rz  zf
             fs  sz  zf

        105  ae  eq  qa
             as  qa  sq
             eq  qr  re
             eq  qz  ze
             fq  qz  zf
             qr  rs  sq
             qt  sq  ts
             qz  sq  zs

        106  ef  fs  se
             fs  qf  sq
             fs  sz  zf
```

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
10
Locate conflicting triads

     CLIENT  P1  P2  P3
        107  ae  es  sa
             ar  rs  sa
             at  qa  tq
             at  sa  ts
             fr  rs  sf

        113  ar  rz  za

        114  ae  er  ra
             ae  et  ta
             ae  ez  za
             af  fr  ra
             af  ft  ta
             as  ra  sr
             ef  fs  se
             er  qe  rq
             et  se  ts
             ez  se  zs
             fr  qf  rq
             qs  rq  sr
             qz  rq  zr
             rt  sr  ts

        115  ae  ef  fa
             aq  fa  qf
             aq  qr  ra
             aq  qz  za
             ef  fr  re

        116  ae  er  ra
             aq  qr  ra
             at  ra  tr
             er  rs  se
             ft  rf  tr
             qr  rs  sq
             rs  st  tr

        117  ft  rf  tr
             fz  rf  zr

        119  qr  rs  sq
             qr  rt  tq
             qr  rz  zq
```

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10
10
Locate conflicting triads

     CLIENT  P1  P2  P3

        120  eq  fe  qf
             eq  qt  te
             eq  qz  ze
             er  fe  rf
             er  rt  te
             er  rz  ze
             ft  tz  zf

        121  ef  fz  ze
             er  rz  ze
             et  tz  ze

        122  az  qa  zq
             ef  fr  re
             ef  fs  se
             et  se  ts

        123  ft  sf  ts
             qt  sq  ts

        124  ez  qe  zq
             qr  rz  zq

        128  ef  fs  se

        129  et  tz  ze

        133  et  qe  tq
```

Section B

This section shows a compilation of each client's preferences. The colums are represented as follows:

Column	Meaning
OBS	Serial number of the clients whose preferences were analysed
CLIENT	Code number of client as used in the collation of Appendix 5.2
PREF	Preference ordering of eight needs starting from most-frequent to least-frequent. Needs in brackets indicate ties which arose due to intransitive choices.
A,E,F,etc.	Refer to needs as coded in Section A of this Appendix
VOTES	The total number of preference choices made by the client. This column shows that some paired-needs were not voted for by some clients.

```
/home/sufs1/ru8/su/suqajsmi/others/chinyio sq110
11
Print ranking of choices
```

OBS	CLIENT	PREF	A	E	F	Q	R	S	T	Z	VOTES	TRIADS
1	1	q(fs)(aetz)r	3	3	5	6	0	5	3	3	28	9
2	2	qs(ae)(rt)fz	4	4	1	7	3	6	3	0	28	2
3	3	qrafzset	5	1	4	7	6	2	0	3	28	0
4	4	sq(ae)t(fz)r	4	4	2	6	0	7	3	2	28	3
5	5	qsfztera	0	2	5	7	1	6	3	4	28	0
6	6	(fz)qrta(es)	2	1	6	5	4	1	3	6	28	6
7	7	(ef)qzs(rt)a	0	5	5	4	1	2	1	3	21	0
8	8	(qs)(afz)(et)r	4	2	4	6	0	6	2	4	28	6
9	9	sfq(arz)te	3	0	6	5	3	7	1	3	28	1
10	10	sqfzaert	3	2	5	6	1	7	0	4	28	0
11	11	(aq)(fr)zset	6	1	5	6	5	2	0	3	28	2

OBS	CLIENT	PREF	A	E	F	Q	R	S	T	Z	VOTES	TRIADS
12	12	ste(fqz)ar	1	4	3	3	0	7	6	3	27	1
13	13	r(qs)ez(ft)a	0	4	2	5	7	5	2	3	28	4
14	14	sfqa(erz)t	4	2	6	5	2	7	0	2	28	1
15	15	stqfaerz	3	2	4	5	1	7	6	0	28	0
16	16	sqazrfet	5	1	2	6	3	7	0	4	28	0
17	17	(aq)(er)(fs)zt	6	4	3	6	4	3	0	2	28	7
18	18	sefqarzt	3	6	5	4	2	7	0	1	28	0
19	19	sqrfatze	3	0	4	6	5	7	2	1	28	0
20	20	sqzt(afr)e	2	0	2	6	2	7	4	5	28	1
21	21	sz(fr)qa(et)	2	1	4	3	4	7	1	5	27	4
22	22	fsqzeart	2	3	7	5	1	6	0	4	28	0
23	23	f(qs)t(er)az	1	3	6	5	3	5	4	0	27	3
24	24	tzf(qr)(es)a	0	2	5	3	3	2	7	6	28	2
25	25	qsafeztr	5	3	4	7	0	6	1	2	28	0
26	26	(fqs)aterz	4	2	5	5	1	5	3	0	25	1
27	27	sqafeztr	5	3	4	6	0	7	1	2	28	0
28	28	sqafertz	5	3	4	6	2	7	1	0	28	0
29	29	(afs)(eqz)tr	6	3	6	3	0	6	1	3	28	2
30	30	sfqeartz	3	4	6	5	2	7	1	0	28	0
31	31	q(fz)e(rt)sa	0	4	5	7	3	1	3	5	28	3
32	32	sfeqatzr	3	5	6	4	0	7	2	1	28	0
33	33	faqetrsz	6	4	7	5	2	1	3	0	28	0
34	34	rt(fs)ezqa	0	3	4	1	6	4	5	2	25	3
35	35	sfzeqatr	2	4	6	3	0	7	1	5	28	0
36	36	sq(fz)eart	2	3	4	6	1	7	0	4	27	1
37	37	qr(ft)s(az)e	2	0	4	7	6	3	4	2	28	3
38	38	(fz)a(qt)esr	5	2	6	4	0	1	4	6	28	3

OBS	CLIENT	PREF	A	E	F	Q	R	S	T	Z	VOTES	TRIADS
39	39	(qs)fet(az)r	2	4	5	6	0	6	3	2	28	5
40	40	sfq(ae)trz	3	3	6	5	1	7	2	0	27	0
41	41	aqf(esz)tr	7	3	5	6	0	3	1	3	28	1
42	42	qarfstez	6	1	4	7	5	3	2	0	28	0
43	43	fqs(ert)az	2	3	7	5	3	4	3	1	28	9
44	44	(fq)se(ar)zt	3	4	6	6	3	5	0	1	28	4
45	45	(fqs)t(aer)z	1	1	4	4	1	4	2	0	17	1
46	46	(fqs)rztae	1	0	5	5	4	5	2	3	25	0
47	47	eqs(ftz)ra	0	7	3	6	1	5	3	3	28	1
48	48	sq(eftz)(ar)	0	2	2	4	0	5	2	2	17	0
49	49	sqfeztra	0	4	5	6	1	7	2	3	28	0
50	50	sqf(et)(rz)a	0	3	5	6	2	7	3	2	28	2
51	51	qf(ez)st(ar)	1	4	6	7	1	3	2	4	28	4
52	52	sfq(et)(rz)a	0	3	6	5	2	7	3	2	28	2
53	53	(af)qze(rs)t	6	3	6	5	2	2	0	4	28	5
54	54	qfr(esz)(at)	2	3	5	6	4	3	2	3	28	14
55	55	fsqearzt	3	4	7	5	2	6	0	1	28	0
56	56	qs(ez)(ar)ft	3	4	2	6	3	5	1	4	28	12
57	57	sqfeaztr	3	4	5	6	0	7	1	2	28	0
58	58	eq)ftrsza	0	6	5	6	3	2	4	1	27	0
59	59	qz(afs)(er)t	3	2	3	7	2	3	1	6	27	5
60	60	szeftqra	0	5	4	2	1	7	3	6	28	0
61	61	zq(st)re(af)	1	2	1	6	3	4	4	7	28	4
62	62	qzf(rs)(ae)t	2	2	4	7	3	3	1	6	28	6
63	63	sqfeaztr	3	4	5	6	0	7	1	2	28	0
64	64	s(qrt)e(afz)	1	2	1	5	5	7	5	1	27	2
65	65	sf(et)(aqr)z	2	3	6	2	2	7	3	1	26	4
66	66	estfqzra	0	7	4	3	1	6	5	2	28	0
67	67	sf(aq)(ez)tr	4	3	6	4	0	7	1	3	28	2
68	68	sf(aeqtz)r	3	3	4	3	2	7	3	3	28	13

OBS	CLIENT	PREF	A	E	F	Q	R	S	T	Z	VOTES	TRIADS
69	69	fqte(sz)(ar)	1	4	7	6	1	2	5	2	28	2
70	70	sfqertza	0	4	6	5	3	7	2	1	28	0
71	71	teqrfasz	2	6	3	5	4	1	7	0	28	0
72	72	q(az)(ef)rst	5	4	4	7	2	1	0	5	28	2
73	73	efq(tz)s(ar)	1	7	6	5	1	2	3	3	28	3
74	74	eq(fs)r(tz)a	0	7	4	6	3	4	2	2	28	3
75	75	(fs)t(qrz)ea	0	2	6	3	3	6	5	3	28	6
76	76	fsqzreta	0	2	7	5	3	6	1	4	28	0
77	78	q(ae)tsr(fz)	5	5	1	7	2	3	4	1	28	5
78	79	sfzqtera	0	2	6	4	1	7	3	5	28	0
79	80	s(eq)(fz)r(at)	1	4	3	4	2	5	1	3	23	5
80	81	sreaqztf	4	5	0	3	6	7	1	2	28	0
81	82	s(fr)q(ez)at	1	2	5	4	5	7	0	2	26	0
82	83	sqef(art)z	2	5	4	6	2	7	2	0	28	1
83	84	sfqe(art)z	2	4	6	5	2	7	2	0	28	1
84	85	sr(ez)f(qt)a	0	4	3	2	6	7	2	4	28	3
85	86	esqftzar	1	7	4	5	0	6	3	2	28	0
86	87	szfeqtra	0	4	5	3	1	7	2	6	28	0
87	88	(efqt)(arsz)	3	4	4	4	3	3	4	3	28	20
88	89	(fs)qetzra	0	4	6	5	1	6	3	2	27	4
89	90	feqt(ars)z	2	6	7	5	2	2	3	1	28	4
90	91	(fq)(rs)z(ae)t	2	2	6	6	4	4	0	3	27	3
91	92	sqfzetar	1	3	5	6	0	7	2	4	28	0
92	93	sqetrfaz	1	5	2	6	3	7	4	0	28	0
93	94	s(efq)(az)(rt)	2	5	5	5	1	7	1	2	28	3
94	95	qf(ar)(ez)st	4	3	5	7	4	2	0	3	28	6
95	96	sf(aqr)ezt	4	2	5	4	4	7	0	1	27	1
96	97	qs(fz)t(ar)e	2	0	4	7	2	6	3	4	28	3
97	98	(fs)e(rt)(qz)a	0	5	6	2	3	6	3	2	27	2

OBS	CLIENT	PREF	A	E	F	Q	R	S	T	Z	VOTES	TRIADS
98	99	q(rs)(ez)atf	3	4	0	6	5	5	1	4	28	6
99	100	fqz(ars)(et)	3	2	6	5	3	3	2	4	28	14
100	101	(ef)q(rstz)a	0	6	6	4	3	3	3	3	28	8
101	102	zeqaftrs	4	6	3	5	1	0	2	7	28	0
102	103	sqz(ef)tra	0	3	3	6	1	7	2	4	26	0
103	104	(fq)(ers)zta	0	4	6	6	4	4	1	3	28	5
104	105	(fz)(qr)(ae)(st)	3	3	6	4	4	1	1	6	28	8
105	106	(es)z(fq)rta	0	6	4	4	2	6	1	5	28	3
106	107	(qt)(ae)s(fr)z	4	4	2	6	2	3	6	0	27	5
107	108	qefstzar	1	6	5	7	0	4	3	2	28	0
108	109	s(fq)aeztr	4	3	5	5	0	7	1	2	27	0
109	110	qezrsfta	0	6	2	7	4	3	1	5	28	0
110	112	rqezftsa	0	5	3	6	7	1	2	4	28	0
111	113	fqets(arz)	1	5	7	6	1	3	4	1	28	1
112	114	qze(afr)(st)	3	4	3	6	3	2	2	5	28	14
113	115	st(qz)(afr)e	2	1	2	4	2	7	6	4	28	5
114	116	s(aq)re(ft)z	5	3	2	5	4	6	2	0	27	7
115	117	seqa(ft)(rz)	4	6	2	5	1	7	2	1	28	2
116	118	sfqteazr	2	3	6	5	0	7	4	1	28	0
117	119	(rs)z(qt)afe	2	0	1	4	6	6	4	5	28	3
118	120	sqr(eftz)a	0	3	3	5	4	7	3	3	28	7
119	121	aqs(et)f(rz)	7	3	2	6	1	5	3	1	28	3
120	122	(aqz)(fr)e(st)	6	2	3	6	3	1	1	6	28	4
121	123	(qs)ftaerz	3	2	5	6	1	6	4	0	27	2
122	124	a(eq)(rz)fst	7	5	2	5	4	1	0	4	28	2
123	125	sfq(ez)tra	0	3	6	5	1	7	2	3	27	0
124	126	zfeqtras	1	5	6	4	2	0	3	7	28	0
125	127	(qt)(ef)zs(ar)	0	3	3	4	0	1	4	2	17	0
126	128	q(efs)tzar	1	5	5	7	0	5	3	2	28	1

OBS	CLIENT	PREF	A	E	F	Q	R	S	T	Z	VOTES	TRIADS
127	129	(etz)sqfra	0	6	2	3	1	4	6	6	28	1
128	130	fsqrzaet	2	1	7	5	4	6	0	3	28	0
129	131	e(afqrstz)	0	1	0	0	0	0	0	0	1	0
130	132	sqzfreta	0	2	4	6	3	7	1	5	28	0
131	133	(ae)(fqrstz)	2	2	1	1	1	1	1	1	10	1

Section C

This section contains summary information which can be obtained from Section A & B. Votes refers to the total number of vates made by each client while triads refers to the number of intransitive choices made by the clients.

```
/home/sufsl/ru8/su/suqajsmi/others/chinyio sql10:
Print ranking of choices
```

VOTES	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	0.8	1	0.8
10	1	0.8	2	1.5
17	3	2.3	5	3.8
21	1	0.8	6	4.6
23	1	0.8	7	5.3
25	3	2.3	10	7.6
26	3	2.3	13	9.9
27	17	13.0	30	22.9
28	101	77.1	131	100.0

TRIADS	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	50	38.2	50	38.2
1	16	12.2	66	50.4
2	14	10.7	80	61.1
3	15	11.5	95	72.5
4	9	6.9	104	79.4
5	8	6.1	112	85.5
6	6	4.6	118	90.1
7	3	2.3	121	92.4
8	2	1.5	123	93.9
9	2	1.5	125	95.4
12	1	0.8	126	96.2
13	1	0.8	127	96.9
14	3	2.3	130	99.2
20	1	0.8	131	100.0

/home/sufs1/ru8/su/suqajsmi/others/chinyio sql10:
Print ranking of choices

	TRIADS														
	0	1	2	3	4	5	6	7	8	9	12	13	14	20	ALL
	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
VOTES															
1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
10	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
17	2	1	.	.	.	.	.	.	.	.	.	.	.	.	3
21	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
23	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
25	1	1	.	1	.	.	.	.	.	.	.	.	.	.	3
26	2	.	.	.	1	.	.	.	.	.	.	.	.	.	3
27	4	3	3	2	2	2	.	1	.	.	.	.	.	.	17
28	39	10	11	12	6	5	6	2	2	2	1	1	3	1	101
Total	50	16	14	15	9	8	6	3	2	2	1	1	3	1	131

APPENDIX H : CLASSIFICATION OF CONSTRUCTION CLIENTS

APPENDIX H :CLASSIFICATION OF CONSTRUCTION CLIENTS

(Output of cluster analysis in respect of classifying 115 construction clients)

* * * * * * * * * * * * * * P R O X I M I T I E S * * * * * * * * * * * * * *

Data Information

115 unweighted cases accepted.
0 cases rejected because of missing value.

City Block measure used.

- -

City Block Dissimilarity Coefficient Matrix

Client	C2	C3	C4	C5	C6
C3	20.0000				
C4	6.0000	22.0000			
C5	16.0000	20.0000	16.0000		
C6	28.0000	18.0000	28.0000	18.0000	
C7	27.0000	21.0000	25.0000	17.0000	21.0000
C8	12.0000	12.0000	10.0000	10.0000	24.0000
C9	18.0000	16.0000	16.0000	14.0000	16.0000
C10	18.0000	16.0000	14.0000	8.0000	20.0000
C11	22.0000	6.0000	22.0000	20.0000	16.0000
C12	20.0000	30.0000	14.0000	16.0000	28.0000
C13	16.0000	18.0000	16.0000	16.0000	24.0000
C14	18.0000	16.0000	14.0000	12.0000	20.0000
C15	14.0000	24.0000	14.0000	14.0000	24.0000
C16	14.0000	12.0000	12.0000	16.0000	22.0000
C17	12.0000	10.0000	16.0000	24.0000	26.0000
C18	16.0000	22.0000	16.0000	18.0000	26.0000
C19	16.0000	14.0000	16.0000	16.0000	18.0000
C21	26.0000	18.0000	24.0000	16.0000	14.0000
C22	20.0000	20.0000	18.0000	10.0000	18.0000
C23	14.0000	26.0000	18.0000	12.0000	20.0000
C24	30.0000	24.0000	30.0000	16.0000	12.0000
C25	10.0000	14.0000	8.0000	12.0000	26.0000
C26	11.0000	19.0000	13.0000	11.0000	19.0000
C27	12.0000	16.0000	6.0000	14.0000	26.0000
C28	8.0000	16.0000	10.0000	16.0000	26.0000
C29	18.0000	20.0000	14.0000	16.0000	24.0000
C30	12.0000	22.0000	14.0000	16.0000	22.0000
C31	22.0000	18.0000	24.0000	12.0000	12.0000
C32	16.0000	26.0000	12.0000	16.0000	24.0000
C33	14.0000	20.0000	18.0000	22.0000	18.0000

* * * * * * * * * * * * * P R O X I M I T I E S * * * * * * * * * * * * *

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C2	C3	C4	C5	C6
C34	27.0000	25.0000	27.0000	19.0000	25.0000
C35	22.0000	26.0000	16.0000	14.0000	20.0000
C36	18.0000	18.0000	14.0000	10.0000	20.0000
C37	20.0000	12.0000	24.0000	16.0000	14.0000
C38	24.0000	20.0000	20.0000	18.0000	10.0000
C39	12.0000	22.0000	10.0000	6.0000	22.0000
C40	12.0000	24.0000	12.0000	14.0000	22.0000
C41	18.0000	14.0000	14.0000	16.0000	22.0000
C42	14.0000	8.0000	20.0000	20.0000	20.0000
C44	16.0000	18.0000	18.0000	16.0000	20.0000
C46	22.0000	18.0000	20.0000	12.0000	12.0000
C47	16.0000	24.0000	14.0000	10.0000	24.0000
C49	16.0000	22.0000	12.0000	6.0000	22.0000
C50	12.0000	24.0000	12.0000	8.0000	22.0000
C51	20.0000	20.0000	18.0000	10.0000	18.0000
C52	14.0000	26.0000	14.0000	10.0000	20.0000
C53	22.0000	14.0000	22.0000	20.0000	16.0000
C55	14.0000	20.0000	16.0000	16.0000	22.0000
C57	14.0000	20.0000	8.0000	12.0000	24.0000
C58	18.0000	20.0000	22.0000	14.0000	20.0000
C59	18.0000	12.0000	18.0000	12.0000	18.0000
C60	22.0000	30.0000	18.0000	12.0000	22.0000
C61	20.0000	24.0000	20.0000	14.0000	16.0000
C62	24.0000	10.0000	26.0000	14.0000	10.0000
C63	14.0000	20.0000	8.0000	12.0000	24.0000
C64	10.0000	22.0000	12.0000	18.0000	24.0000
C65	15.0000	27.0000	17.0000	19.0000	23.0000
C66	20.0000	30.0000	18.0000	14.0000	28.0000
C67	16.0000	20.0000	10.0000	16.0000	24.0000
C69	20.0000	24.0000	16.0000	14.0000	20.0000
C70	16.0000	24.0000	16.0000	12.0000	20.0000
C71	20.0000	24.0000	24.0000	26.0000	20.0000
C72	16.0000	12.0000	18.0000	20.0000	20.0000
C73	27.0000	21.0000	27.0000	29.0000	17.0000
C74	20.0000	20.0000	20.0000	14.0000	22.0000
C75	18.0000	18.0000	20.0000	22.0000	24.0000
C76	22.0000	20.0000	22.0000	8.0000	16.0000
C78	8.0000	20.0000	12.0000	22.0000	28.0000
C79	22.0000	26.0000	18.0000	6.0000	16.0000
C80	14.0000	14.0000	10.0000	12.0000	24.0000
C81	16.0000	20.0000	14.0000	26.0000	30.0000
C82	20.0000	14.0000	18.0000	16.0000	22.0000
C83	30.0000	16.0000	30.0000	22.0000	14.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C2	C3	C4	C5	C6
C84	12.0000	24.0000	12.0000	14.0000	22.0000
C85	24.0000	24.0000	22.0000	18.0000	26.0000
C86	16.0000	26.0000	12.0000	12.0000	24.0000
C87	22.0000	28.0000	18.0000	10.0000	20.0000
C89	26.0000	18.0000	26.0000	18.0000	20.0000
C90	18.0000	26.0000	22.0000	18.0000	20.0000
C91	18.0000	18.0000	18.0000	14.0000	22.0000
C92	18.0000	22.0000	12.0000	6.0000	20.0000
C93	10.0000	26.0000	12.0000	16.0000	26.0000
C94	28.0000	24.0000	28.0000	14.0000	16.0000
C95	18.0000	8.0000	20.0000	20.0000	16.0000
C96	24.0000	22.0000	24.0000	14.0000	18.0000
C97	16.0000	18.0000	16.0000	6.0000	14.0000
C98	22.0000	28.0000	20.0000	16.0000	22.0000
C99	18.0000	10.0000	20.0000	20.0000	20.0000
C102	22.0000	22.0000	20.0000	22.0000	16.0000
C103	18.0000	22.0000	14.0000	6.0000	20.0000
C104	20.0000	18.0000	20.0000	14.0000	18.0000
C106	20.0000	26.0000	18.0000	14.0000	24.0000
C107	10.0000	22.0000	12.0000	22.0000	28.0000
C108	16.0000	22.0000	14.0000	10.0000	22.0000
C109	16.0000	20.0000	10.0000	14.0000	22.0000
C110	20.0000	18.0000	22.0000	16.0000	20.0000
C112	24.0000	16.0000	24.0000	18.0000	18.0000
C113	19.0000	25.0000	19.0000	13.0000	21.0000
C115	20.0000	24.0000	18.0000	12.0000	18.0000
C116	10.0000	18.0000	12.0000	22.0000	26.0000
C117	12.0000	24.0000	8.0000	18.0000	28.0000
C118	16.0000	26.0000	12.0000	12.0000	20.0000
C119	22.0000	22.0000	22.0000	20.0000	18.0000
C120	18.0000	16.0000	16.0000	10.0000	18.0000
C121	6.0000	22.0000	8.0000	18.0000	28.0000
C122	27.0000	17.0000	27.0000	25.0000	17.0000
C123	12.0000	22.0000	12.0000	10.0000	22.0000
C124	18.0000	12.0000	18.0000	26.0000	22.0000
C125	18.0000	24.0000	14.0000	8.0000	20.0000
C126	26.0000	26.0000	26.0000	18.0000	10.0000
C128	14.0000	22.0000	12.0000	8.0000	22.0000
C129	24.0000	32.0000	22.0000	18.0000	24.0000
C130	22.0000	14.0000	22.0000	14.0000	14.0000
C132	20.0000	18.0000	18.0000	8.0000	18.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C7	C8	C9	C10	C11
C8	21.0000				
C9	19.0000	10.0000			
C10	17.0000	8.0000	8.0000		
C11	19.0000	14.0000	14.0000	14.0000	
C12	19.0000	18.0000	20.0000	18.0000	30.0000
C13	21.0000	20.0000	22.0000	20.0000	22.0000
C14	15.0000	8.0000	4.0000	4.0000	14.0000
C15	25.0000	14.0000	14.0000	12.0000	24.0000
C16	25.0000	10.0000	10.0000	8.0000	12.0000
C17	23.0000	16.0000	22.0000	20.0000	12.0000
C18	13.0000	16.0000	12.0000	10.0000	20.0000
C19	27.0000	14.0000	10.0000	12.0000	16.0000
C21	21.0000	18.0000	12.0000	10.0000	16.0000
C22	11.0000	12.0000	10.0000	6.0000	18.0000
C23	17.0000	18.0000	14.0000	16.0000	24.0000
C24	19.0000	26.0000	24.0000	22.0000	22.0000
C25	21.0000	2.0000	12.0000	10.0000	16.0000
C26	20.0000	11.0000	11.0000	11.0000	17.0000
C27	21.0000	4.0000	10.0000	8.0000	16.0000
C28	23.0000	8.0000	10.0000	10.0000	16.0000
C29	17.0000	8.0000	10.0000	12.0000	16.0000
C30	17.0000	14.0000	8.0000	10.0000	20.0000
C31	15.0000	20.0000	22.0000	18.0000	18.0000
C32	15.0000	14.0000	12.0000	12.0000	24.0000
C33	17.0000	20.0000	18.0000	22.0000	16.0000
C34	24.0000	27.0000	25.0000	25.0000	27.0000
C35	15.0000	14.0000	12.0000	10.0000	24.0000
C36	17.0000	10.0000	12.0000	4.0000	18.0000
C37	25.0000	20.0000	18.0000	20.0000	16.0000
C38	19.0000	16.0000	18.0000	18.0000	18.0000
C39	17.0000	10.0000	16.0000	12.0000	22.0000
C40	17.0000	14.0000	10.0000	10.0000	22.0000
C41	17.0000	8.0000	14.0000	12.0000	8.0000
C42	27.0000	14.0000	18.0000	20.0000	10.0000
C44	13.0000	16.0000	14.0000	12.0000	16.0000
C46	19.0000	16.0000	6.0000	12.0000	16.0000
C47	13.0000	16.0000	20.0000	16.0000	24.0000
C49	13.0000	12.0000	12.0000	8.0000	20.0000
C50	17.0000	16.0000	14.0000	12.0000	22.0000
C51	11.0000	14.0000	18.0000	14.0000	20.0000
C52	15.0000	18.0000	12.0000	14.0000	24.0000
C53	13.0000	16.0000	14.0000	14.0000	10.0000
C55	13.0000	14.0000	10.0000	10.0000	18.0000
C57	17.0000	8.0000	10.0000	6.0000	18.0000
C58	13.0000	22.0000	24.0000	22.0000	20.0000
C59	19.0000	8.0000	14.0000	8.0000	14.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C7	C8	C9	C10	C11
C60	17.0000	20.0000	20.0000	16.0000	30.0000
C61	25.0000	22.0000	24.0000	20.0000	24.0000
C62	19.0000	16.0000	16.0000	12.0000	10.0000
C63	17.0000	8.0000	10.0000	6.0000	18.0000
C64	29.0000	20.0000	20.0000	18.0000	24.0000
C65	20.0000	21.0000	15.0000	17.0000	25.0000
C66	15.0000	20.0000	22.0000	20.0000	30.0000
C67	17.0000	8.0000	8.0000	10.0000	18.0000
C69	13.0000	18.0000	20.0000	18.0000	22.0000
C70	15.0000	18.0000	12.0000	14.0000	22.0000
C71	21.0000	28.0000	28.0000	28.0000	24.0000
C72	19.0000	14.0000	20.0000	16.0000	12.0000
C73	24.0000	27.0000	27.0000	25.0000	23.0000
C74	11.0000	18.0000	18.0000	16.0000	18.0000
C75	19.0000	16.0000	14.0000	16.0000	16.0000
C76	13.0000	14.0000	10.0000	10.0000	18.0000
C78	23.0000	18.0000	24.0000	24.0000	22.0000
C79	15.0000	16.0000	12.0000	10.0000	24.0000
C80	21.0000	6.0000	10.0000	4.0000	14.0000
C81	25.0000	20.0000	18.0000	20.0000	24.0000
C82	19.0000	16.0000	14.0000	12.0000	18.0000
C83	21.0000	22.0000	14.0000	18.0000	18.0000
C84	17.0000	14.0000	10.0000	10.0000	22.0000
C85	21.0000	24.0000	22.0000	20.0000	28.0000
C86	15.0000	14.0000	18.0000	16.0000	26.0000
C87	15.0000	18.0000	16.0000	12.0000	26.0000
C89	19.0000	18.0000	14.0000	12.0000	18.0000
C90	11.0000	24.0000	20.0000	22.0000	24.0000
C91	21.0000	18.0000	16.0000	16.0000	22.0000
C92	17.0000	10.0000	12.0000	6.0000	20.0000
C93	23.0000	20.0000	20.0000	18.0000	26.0000
C94	19.0000	24.0000	20.0000	20.0000	24.0000
C95	17.0000	14.0000	16.0000	16.0000	8.0000
C96	19.0000	22.0000	16.0000	20.0000	22.0000
C97	23.0000	10.0000	12.0000	10.0000	20.0000
C98	17.0000	24.0000	18.0000	20.0000	26.0000
C99	27.0000	16.0000	20.0000	18.0000	16.0000
C102	17.0000	20.0000	22.0000	20.0000	22.0000
C103	17.0000	12.0000	14.0000	8.0000	22.0000
C104	11.0000	18.0000	16.0000	16.0000	16.0000
C106	13.0000	18.0000	16.0000	14.0000	26.0000
C107	25.0000	18.0000	24.0000	22.0000	22.0000
C108	13.0000	14.0000	20.0000	16.0000	22.0000
C109	17.0000	8.0000	6.0000	8.0000	18.0000
C110	15.0000	20.0000	24.0000	20.0000	20.0000
C112	17.0000	24.0000	26.0000	22.0000	20.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C7	C8	C9	C10	C11
C113	10.0000	21.0000	21.0000	19.0000	23.0000
C115	25.0000	18.0000	12.0000	14.0000	24.0000
C116	27.0000	14.0000	14.0000	16.0000	16.0000
C117	19.0000	12.0000	14.0000	14.0000	24.0000
C118	19.0000	14.0000	12.0000	12.0000	24.0000
C119	31.0000	24.0000	20.0000	22.0000	26.0000
C120	23.0000	16.0000	14.0000	14.0000	18.0000
C121	25.0000	14.0000	20.0000	18.0000	18.0000
C122	24.0000	19.0000	21.0000	21.0000	15.0000
C123	23.0000	12.0000	12.0000	8.0000	20.0000
C124	19.0000	18.0000	22.0000	20.0000	8.0000
C125	11.0000	14.0000	10.0000	10.0000	22.0000
C126	13.0000	26.0000	22.0000	22.0000	24.0000
C128	15.0000	12.0000	18.0000	14.0000	22.0000
C129	17.0000	26.0000	28.0000	24.0000	32.0000
C130	15.0000	14.0000	8.0000	10.0000	12.0000
C132	19.0000	12.0000	12.0000	8.0000	18.0000

Client	C12	C13	C14	C15	C16
C13	22.0000				
C14	18.0000	22.0000			
C15	10.0000	24.0000	12.0000		
C16	24.0000	18.0000	10.0000	18.0000	
C17	28.0000	16.0000	20.0000	24.0000	14.0000
C18	14.0000	22.0000	10.0000	14.0000	16.0000
C19	20.0000	16.0000	14.0000	12.0000	12.0000
C21	20.0000	22.0000	12.0000	20.0000	12.0000
C22	18.0000	20.0000	6.0000	16.0000	14.0000
C23	14.0000	20.0000	14.0000	10.0000	22.0000
C24	20.0000	24.0000	24.0000	20.0000	26.0000
C25	16.0000	20.0000	10.0000	14.0000	12.0000
C26	17.0000	21.0000	9.0000	7.0000	17.0000
C27	14.0000	20.0000	8.0000	12.0000	10.0000
C28	18.0000	20.0000	10.0000	10.0000	10.0000
C29	16.0000	24.0000	8.0000	18.0000	16.0000
C30	16.0000	20.0000	8.0000	10.0000	16.0000
C31	24.0000	16.0000	22.0000	26.0000	22.0000
C32	10.0000	22.0000	10.0000	12.0000	20.0000
C33	24.0000	26.0000	18.0000	18.0000	24.0000
C34	15.0000	15.0000	25.0000	19.0000	29.0000
C35	12.0000	22.0000	10.0000	18.0000	18.0000
C36	16.0000	18.0000	8.0000	14.0000	10.0000
C37	24.0000	18.0000	22.0000	18.0000	22.0000
C38	24.0000	30.0000	16.0000	22.0000	22.0000
C39	10.0000	16.0000	14.0000	14.0000	20.0000

*************PROXIMITIES*************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C12	C13	C14	C15	C16
C40	14.0000	20.0000	8.0000	8.0000	18.0000
C41	22.0000	22.0000	12.0000	20.0000	16.0000
C42	28.0000	20.0000	20.0000	18.0000	16.0000
C44	20.0000	16.0000	12.0000	18.0000	16.0000
C46	18.0000	16.0000	10.0000	16.0000	14.0000
C47	14.0000	12.0000	18.0000	18.0000	20.0000
C49	12.0000	12.0000	10.0000	14.0000	16.0000
C50	12.0000	14.0000	14.0000	12.0000	18.0000
C51	16.0000	18.0000	16.0000	22.0000	22.0000
C52	12.0000	16.0000	12.0000	12.0000	20.0000
C53	28.0000	26.0000	12.0000	24.0000	16.0000
C55	18.0000	20.0000	8.0000	14.0000	16.0000
C57	12.0000	18.0000	8.0000	12.0000	14.0000
C58	18.0000	18.0000	24.0000	20.0000	26.0000
C59	24.0000	22.0000	10.0000	18.0000	12.0000
C60	10.0000	20.0000	18.0000	18.0000	22.0000
C61	22.0000	14.0000	24.0000	20.0000	18.0000
C62	28.0000	20.0000	16.0000	24.0000	14.0000
C63	12.0000	18.0000	8.0000	12.0000	14.0000
C64	18.0000	12.0000	20.0000	12.0000	16.0000
C65	11.0000	23.0000	15.0000	11.0000	21.0000
C66	6.0000	20.0000	20.0000	14.0000	26.0000
C67	14.0000	24.0000	6.0000	14.0000	14.0000
C69	12.0000	20.0000	18.0000	16.0000	26.0000
C70	14.0000	14.0000	12.0000	14.0000	18.0000
C71	18.0000	22.0000	28.0000	16.0000	28.0000
C72	28.0000	22.0000	18.0000	26.0000	14.0000
C73	29.0000	21.0000	27.0000	31.0000	23.0000
C74	18.0000	14.0000	18.0000	22.0000	20.0000
C75	22.0000	24.0000	12.0000	20.0000	16.0000
C76	20.0000	16.0000	10.0000	18.0000	14.0000
C78	22.0000	20.0000	24.0000	20.0000	20.0000
C79	14.0000	20.0000	10.0000	14.0000	18.0000
C80	20.0000	20.0000	6.0000	14.0000	4.0000
C81	18.0000	14.0000	18.0000	22.0000	16.0000
C82	16.0000	12.0000	12.0000	16.0000	14.0000
C83	28.0000	22.0000	18.0000	26.0000	20.0000
C84	14.0000	20.0000	8.0000	8.0000	18.0000
C85	16.0000	12.0000	22.0000	24.0000	20.0000
C86	8.0000	18.0000	16.0000	14.0000	22.0000
C87	12.0000	18.0000	14.0000	18.0000	20.0000
C89	24.0000	22.0000	12.0000	22.0000	16.0000
C90	16.0000	22.0000	20.0000	16.0000	28.0000
C91	16.0000	10.0000	16.0000	14.0000	18.0000
C92	12.0000	16.0000	10.0000	14.0000	14.0000
C93	12.0000	14.0000	20.0000	12.0000	16.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C12	C13	C14	C15	C16
C94	22.0000	18.0000	20.0000	24.0000	24.0000
C95	28.0000	22.0000	14.0000	24.0000	16.0000
C96	16.0000	18.0000	18.0000	18.0000	22.0000
C97	18.0000	20.0000	14.0000	14.0000	14.0000
C98	12.0000	18.0000	18.0000	20.0000	24.0000
C99	32.0000	14.0000	20.0000	26.0000	14.0000
C102	24.0000	24.0000	20.0000	24.0000	22.0000
C103	14.0000	14.0000	12.0000	14.0000	14.0000
C104	20.0000	12.0000	16.0000	22.0000	20.0000
C106	14.0000	16.0000	16.0000	20.0000	16.0000
C107	18.0000	22.0000	22.0000	12.0000	20.0000
C108	12.0000	18.0000	18.0000	18.0000	24.0000
C109	14.0000	22.0000	4.0000	12.0000	14.0000
C110	24.0000	12.0000	24.0000	28.0000	18.0000
C112	24.0000	8.0000	26.0000	28.0000	22.0000
C113	15.0000	19.0000	19.0000	17.0000	27.0000
C115	12.0000	20.0000	16.0000	10.0000	14.0000
C116	22.0000	18.0000	14.0000	14.0000	10.0000
C117	12.0000	20.0000	12.0000	12.0000	16.0000
C118	10.0000	22.0000	10.0000	8.0000	20.0000
C119	22.0000	14.0000	24.0000	20.0000	18.0000
C120	18.0000	10.0000	16.0000	16.0000	12.0000
C121	20.0000	18.0000	18.0000	14.0000	16.0000
C122	29.0000	29.0000	21.0000	27.0000	19.0000
C123	14.0000	22.0000	10.0000	4.0000	16.0000
C124	28.0000	18.0000	20.0000	28.0000	14.0000
C125	12.0000	14.0000	8.0000	14.0000	18.0000
C126	20.0000	24.0000	22.0000	26.0000	28.0000
C128	10.0000	16.0000	16.0000	16.0000	22.0000
C129	12.0000	20.0000	26.0000	20.0000	26.0000
C130	22.0000	18.0000	8.0000	18.0000	12.0000
C132	18.0000	14.0000	12.0000	16.0000	10.0000

Client	C17	C18	C19	C21	C22
C18	18.0000				
C19	16.0000	14.0000			
C21	24.0000	14.0000	14.0000		
C22	22.0000	12.0000	18.0000	12.0000	
C23	24.0000	14.0000	16.0000	20.0000	10.0000
C24	30.0000	26.0000	26.0000	18.0000	22.0000
C25	14.0000	14.0000	14.0000	20.0000	12.0000
C26	19.0000	13.0000	13.0000	19.0000	13.0000
C27	16.0000	12.0000	12.0000	18.0000	12.0000
C28	14.0000	10.0000	10.0000	18.0000	14.0000
C29	20.0000	14.0000	20.0000	16.0000	10.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C17	C18	C19	C21	C22
C30	18.0000	6.0000	12.0000	16.0000	10.0000
C31	20.0000	22.0000	22.0000	18.0000	18.0000
C32	22.0000	6.0000	14.0000	18.0000	12.0000
C33	16.0000	18.0000	22.0000	28.0000	18.0000
C34	27.0000	23.0000	21.0000	21.0000	23.0000
C35	26.0000	12.0000	20.0000	10.0000	8.0000
C36	20.0000	12.0000	14.0000	10.0000	6.0000
C37	16.0000	22.0000	10.0000	20.0000	22.0000
C38	26.0000	24.0000	26.0000	20.0000	18.0000
C39	20.0000	14.0000	16.0000	20.0000	12.0000
C40	20.0000	8.0000	12.0000	18.0000	10.0000
C41	14.0000	18.0000	20.0000	22.0000	14.0000
C42	8.0000	22.0000	10.0000	22.0000	24.0000
C44	14.0000	10.0000	14.0000	16.0000	8.0000
C46	24.0000	16.0000	8.0000	10.0000	12.0000
C47	22.0000	16.0000	20.0000	24.0000	16.0000
C49	22.0000	12.0000	14.0000	16.0000	10.0000
C50	20.0000	10.0000	12.0000	18.0000	14.0000
C51	20.0000	18.0000	22.0000	22.0000	12.0000
C52	22.0000	10.0000	14.0000	18.0000	12.0000
C53	16.0000	18.0000	24.0000	20.0000	10.0000
C55	16.0000	6.0000	14.0000	16.0000	6.0000
C57	18.0000	8.0000	12.0000	16.0000	10.0000
C58	18.0000	16.0000	20.0000	26.0000	22.0000
C59	16.0000	18.0000	18.0000	14.0000	12.0000
C60	30.0000	16.0000	22.0000	14.0000	16.0000
C61	24.0000	28.0000	22.0000	20.0000	22.0000
C62	16.0000	20.0000	16.0000	8.0000	14.0000
C63	18.0000	8.0000	12.0000	16.0000	10.0000
C64	16.0000	18.0000	10.0000	20.0000	20.0000
C65	23.0000	9.0000	15.0000	17.0000	17.0000
C66	28.0000	14.0000	22.0000	22.0000	18.0000
C67	20.0000	10.0000	16.0000	16.0000	10.0000
C69	22.0000	20.0000	22.0000	26.0000	14.0000
C70	20.0000	10.0000	12.0000	16.0000	12.0000
C71	20.0000	20.0000	22.0000	28.0000	26.0000
C72	10.0000	20.0000	24.0000	22.0000	18.0000
C73	19.0000	25.0000	25.0000	19.0000	25.0000
C74	18.0000	12.0000	18.0000	20.0000	16.0000
C75	16.0000	12.0000	16.0000	14.0000	12.0000
C76	24.0000	16.0000	16.0000	12.0000	6.0000
C78	12.0000	18.0000	22.0000	32.0000	26.0000
C79	30.0000	16.0000	18.0000	12.0000	10.0000
C80	16.0000	14.0000	14.0000	14.0000	10.0000
C81	16.0000	14.0000	16.0000	18.0000	22.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C17	C18	C19	C21	C22
C82	16.0000	12.0000	10.0000	12.0000	12.0000
C83	24.0000	22.0000	16.0000	12.0000	16.0000
C84	20.0000	8.0000	12.0000	18.0000	10.0000
C85	24.0000	18.0000	18.0000	16.0000	20.0000
C86	24.0000	12.0000	18.0000	22.0000	14.0000
C87	28.0000	14.0000	20.0000	10.0000	12.0000
C89	22.0000	16.0000	16.0000	10.0000	10.0000
C90	22.0000	14.0000	22.0000	26.0000	16.0000
C91	18.0000	14.0000	8.0000	16.0000	16.0000
C92	24.0000	14.0000	14.0000	14.0000	8.0000
C93	18.0000	14.0000	14.0000	22.0000	20.0000
C94	28.0000	24.0000	20.0000	14.0000	16.0000
C95	10.0000	18.0000	18.0000	20.0000	16.0000
C96	26.0000	20.0000	14.0000	14.0000	16.0000
C97	24.0000	20.0000	12.0000	14.0000	12.0000
C98	26.0000	14.0000	18.0000	16.0000	18.0000
C99	12.0000	26.0000	18.0000	20.0000	22.0000
C102	22.0000	20.0000	26.0000	24.0000	20.0000
C103	24.0000	16.0000	14.0000	14.0000	10.0000
C104	16.0000	16.0000	16.0000	18.0000	12.0000
C106	24.0000	10.0000	20.0000	14.0000	14.0000
C107	14.0000	22.0000	22.0000	32.0000	24.0000
C108	20.0000	14.0000	20.0000	24.0000	16.0000
C109	20.0000	10.0000	14.0000	16.0000	8.0000
C110	14.0000	20.0000	22.0000	20.0000	20.0000
C112	18.0000	24.0000	20.0000	24.0000	22.0000
C113	21.0000	17.0000	21.0000	27.0000	15.0000
C115	28.0000	20.0000	14.0000	16.0000	16.0000
C116	10.0000	14.0000	12.0000	18.0000	18.0000
C117	18.0000	8.0000	14.0000	22.0000	16.0000
C118	24.0000	12.0000	14.0000	18.0000	10.0000
C119	26.0000	26.0000	16.0000	16.0000	22.0000
C120	20.0000	20.0000	8.0000	14.0000	18.0000
C121	12.0000	18.0000	18.0000	28.0000	20.0000
C122	21.0000	25.0000	25.0000	17.0000	23.0000
C123	22.0000	12.0000	10.0000	18.0000	14.0000
C124	8.0000	20.0000	22.0000	24.0000	22.0000
C125	24.0000	12.0000	16.0000	16.0000	8.0000
C126	28.0000	20.0000	28.0000	20.0000	18.0000
C128	20.0000	14.0000	18.0000	22.0000	14.0000
C129	28.0000	22.0000	30.0000	22.0000	22.0000
C130	20.0000	14.0000	12.0000	8.0000	6.0000
C132	22.0000	16.0000	12.0000	10.0000	12.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C23	C24	C25	C26	C27
C24	20.0000				
C25	16.0000	28.0000			
C26	9.0000	21.0000	11.0000		
C27	16.0000	28.0000	2.0000	11.0000	
C28	12.0000	28.0000	6.0000	9.0000	4.0000
C29	16.0000	26.0000	8.0000	13.0000	8.0000
C30	8.0000	26.0000	12.0000	9.0000	10.0000
C31	20.0000	10.0000	20.0000	21.0000	22.0000
C32	12.0000	26.0000	12.0000	11.0000	10.0000
C33	12.0000	22.0000	18.0000	11.0000	18.0000
C34	17.0000	17.0000	25.0000	20.0000	25.0000
C35	16.0000	22.0000	14.0000	17.0000	12.0000
C36	16.0000	22.0000	10.0000	15.0000	8.0000
C37	16.0000	20.0000	20.0000	15.0000	22.0000
C38	22.0000	14.0000	18.0000	15.0000	18.0000
C39	10.0000	22.0000	8.0000	11.0000	10.0000
C40	8.0000	26.0000	12.0000	7.0000	10.0000
C41	20.0000	24.0000	8.0000	13.0000	8.0000
C42	20.0000	26.0000	14.0000	13.0000	16.0000
C44	10.0000	24.0000	14.0000	13.0000	14.0000
C46	12.0000	20.0000	18.0000	15.0000	16.0000
C47	16.0000	22.0000	16.0000	15.0000	16.0000
C49	12.0000	20.0000	12.0000	13.0000	10.0000
C50	8.0000	20.0000	14.0000	11.0000	12.0000
C51	16.0000	20.0000	14.0000	17.0000	16.0000
C52	6.0000	20.0000	16.0000	11.0000	14.0000
C53	18.0000	20.0000	16.0000	17.0000	16.0000
C55	8.0000	26.0000	12.0000	11.0000	12.0000
C57	14.0000	26.0000	6.0000	11.0000	4.0000
C58	14.0000	16.0000	20.0000	17.0000	22.0000
C59	22.0000	20.0000	10.0000	13.0000	12.0000
C60	18.0000	18.0000	20.0000	19.0000	18.0000
C61	20.0000	12.0000	24.0000	21.0000	24.0000
C62	22.0000	16.0000	18.0000	19.0000	20.0000
C63	14.0000	26.0000	6.0000	11.0000	4.0000
C64	12.0000	26.0000	18.0000	15.0000	16.0000
C65	9.0000	23.0000	19.0000	12.0000	17.0000
C66	14.0000	20.0000	18.0000	17.0000	18.0000
C67	14.0000	26.0000	6.0000	11.0000	4.0000
C69	10.0000	18.0000	16.0000	15.0000	16.0000
C70	8.0000	20.0000	16.0000	13.0000	14.0000
C71	18.0000	16.0000	26.0000	19.0000	26.0000
C72	26.0000	22.0000	14.0000	21.0000	16.0000
C73	31.0000	21.0000	27.0000	28.0000	27.0000
C74	16.0000	20.0000	16.0000	17.0000	16.0000
C75	14.0000	28.0000	14.0000	15.0000	14.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C23	C24	C25	C26	C27
C76	10.0000	16.0000	16.0000	15.0000	16.0000
C78	20.0000	28.0000	16.0000	17.0000	18.0000
C79	12.0000	14.0000	18.0000	13.0000	16.0000
C80	20.0000	26.0000	8.0000	13.0000	6.0000
C81	24.0000	32.0000	18.0000	21.0000	16.0000
C82	14.0000	24.0000	14.0000	17.0000	12.0000
C83	22.0000	22.0000	24.0000	21.0000	24.0000
C84	8.0000	26.0000	12.0000	7.0000	10.0000
C85	22.0000	24.0000	24.0000	25.0000	22.0000
C86	12.0000	24.0000	12.0000	13.0000	12.0000
C87	16.0000	16.0000	18.0000	17.0000	16.0000
C89	18.0000	24.0000	20.0000	19.0000	20.0000
C90	6.0000	20.0000	22.0000	13.0000	22.0000
C91	12.0000	22.0000	16.0000	15.0000	14.0000
C92	12.0000	20.0000	10.0000	13.0000	8.0000
C93	10.0000	24.0000	18.0000	15.0000	16.0000
C94	16.0000	16.0000	26.0000	19.0000	26.0000
C95	20.0000	22.0000	12.0000	17.0000	14.0000
C96	10.0000	18.0000	22.0000	17.0000	22.0000
C97	16.0000	20.0000	12.0000	13.0000	14.0000
C98	14.0000	22.0000	22.0000	19.0000	20.0000
C99	28.0000	24.0000	18.0000	21.0000	20.0000
C102	26.0000	20.0000	20.0000	19.0000	20.0000
C103	14.0000	18.0000	12.0000	15.0000	10.0000
C104	12.0000	20.0000	16.0000	17.0000	16.0000
C106	18.0000	20.0000	18.0000	21.0000	16.0000
C107	18.0000	22.0000	16.0000	13.0000	16.0000
C108	14.0000	22.0000	12.0000	13.0000	14.0000
C109	12.0000	26.0000	6.0000	9.0000	4.0000
C110	24.0000	20.0000	20.0000	25.0000	22.0000
C112	24.0000	18.0000	24.0000	25.0000	24.0000
C113	9.0000	19.0000	19.0000	14.0000	19.0000
C115	14.0000	16.0000	20.0000	17.0000	18.0000
C116	16.0000	30.0000	12.0000	13.0000	10.0000
C117	16.0000	30.0000	10.0000	11.0000	8.0000
C118	6.0000	22.0000	12.0000	9.0000	10.0000
C119	22.0000	20.0000	26.0000	23.0000	26.0000
C120	16.0000	20.0000	18.0000	17.0000	16.0000
C121	16.0000	30.0000	12.0000	9.0000	12.0000
C122	29.0000	17.0000	21.0000	22.0000	21.0000
C123	8.0000	22.0000	12.0000	5.0000	10.0000
C124	28.0000	26.0000	18.0000	23.0000	18.0000
C125	10.0000	20.0000	14.0000	13.0000	12.0000
C126	18.0000	12.0000	26.0000	21.0000	26.0000
C128	12.0000	22.0000	10.0000	11.0000	12.0000

*************PROXIMITIES*************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C23	C24	C25	C26	C27
C129	22.0000	14.0000	26.0000	23.0000	26.0000
C130	12.0000	22.0000	16.0000	15.0000	16.0000
C132	16.0000	16.0000	14.0000	17.0000	12.0000

Client	C28	C29	C30	C31	C32
C29	12.0000				
C30	6.0000	12.0000			
C31	22.0000	24.0000	20.0000		
C32	12.0000	10.0000	6.0000	22.0000	
C33	14.0000	16.0000	12.0000	18.0000	16.0000
C34	25.0000	23.0000	23.0000	23.0000	23.0000
C35	16.0000	8.0000	10.0000	18.0000	8.0000
C36	10.0000	14.0000	12.0000	16.0000	14.0000
C37	20.0000	26.0000	20.0000	18.0000	22.0000
C38	22.0000	14.0000	22.0000	16.0000	18.0000
C39	14.0000	14.0000	12.0000	14.0000	10.0000
C40	8.0000	12.0000	2.0000	20.0000	4.0000
C41	12.0000	8.0000	16.0000	18.0000	16.0000
C42	12.0000	20.0000	18.0000	20.0000	22.0000
C44	12.0000	16.0000	8.0000	16.0000	12.0000
C46	16.0000	16.0000	12.0000	18.0000	14.0000
C47	18.0000	20.0000	18.0000	16.0000	16.0000
C49	12.0000	14.0000	10.0000	12.0000	10.0000
C50	10.0000	18.0000	8.0000	14.0000	10.0000
C51	20.0000	16.0000	16.0000	10.0000	12.0000
C52	12.0000	16.0000	6.0000	16.0000	8.0000
C53	16.0000	12.0000	16.0000	16.0000	20.0000
C55	10.0000	12.0000	4.0000	20.0000	8.0000
C57	8.0000	10.0000	6.0000	18.0000	6.0000
C58	20.0000	26.0000	18.0000	10.0000	18.0000
C59	14.0000	16.0000	18.0000	14.0000	20.0000
C60	20.0000	18.0000	18.0000	16.0000	14.0000
C61	24.0000	28.0000	26.0000	14.0000	28.0000
C62	20.0000	22.0000	20.0000	10.0000	24.0000
C63	8.0000	10.0000	6.0000	18.0000	6.0000
C64	12.0000	24.0000	14.0000	24.0000	18.0000
C65	13.0000	15.0000	7.0000	23.0000	7.0000
C66	20.0000	18.0000	18.0000	22.0000	14.0000
C67	8.0000	4.0000	8.0000	24.0000	6.0000
C69	20.0000	18.0000	16.0000	16.0000	14.0000
C70	12.0000	16.0000	6.0000	14.0000	8.0000
C71	22.0000	30.0000	20.0000	20.0000	22.0000
C72	16.0000	18.0000	20.0000	12.0000	24.0000
C73	27.0000	25.0000	25.0000	17.0000	27.0000
C74	16.0000	20.0000	14.0000	12.0000	16.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C28	C29	C30	C31	C32
C75	12.0000	10.0000	12.0000	26.0000	14.0000
C76	16.0000	14.0000	12.0000	14.0000	16.0000
C78	16.0000	24.0000	20.0000	22.0000	20.0000
C79	18.0000	14.0000	14.0000	16.0000	12.0000
C80	8.0000	12.0000	14.0000	22.0000	16.0000
C81	16.0000	18.0000	16.0000	28.0000	16.0000
C82	12.0000	18.0000	12.0000	20.0000	16.0000
C83	24.0000	18.0000	20.0000	22.0000	22.0000
C84	8.0000	12.0000	2.0000	20.0000	4.0000
C85	22.0000	22.0000	20.0000	20.0000	18.0000
C86	16.0000	16.0000	14.0000	20.0000	10.0000
C87	18.0000	14.0000	14.0000	12.0000	12.0000
C89	20.0000	14.0000	16.0000	24.0000	18.0000
C90	18.0000	22.0000	12.0000	18.0000	14.0000
C91	12.0000	20.0000	12.0000	18.0000	14.0000
C92	12.0000	12.0000	12.0000	14.0000	10.0000
C93	12.0000	24.0000	12.0000	20.0000	14.0000
C94	26.0000	20.0000	22.0000	18.0000	22.0000
C95	14.0000	16.0000	16.0000	14.0000	20.0000
C96	22.0000	18.0000	18.0000	22.0000	18.0000
C97	16.0000	18.0000	18.0000	16.0000	18.0000
C98	20.0000	18.0000	14.0000	20.0000	12.0000
C99	20.0000	24.0000	24.0000	18.0000	28.0000
C102	22.0000	22.0000	22.0000	14.0000	20.0000
C103	12.0000	16.0000	14.0000	12.0000	14.0000
C104	16.0000	18.0000	12.0000	12.0000	16.0000
C106	16.0000	18.0000	14.0000	16.0000	14.0000
C107	14.0000	22.0000	18.0000	24.0000	20.0000
C108	18.0000	18.0000	16.0000	14.0000	12.0000
C109	8.0000	6.0000	6.0000	22.0000	6.0000
C110	22.0000	26.0000	22.0000	10.0000	24.0000
C112	24.0000	28.0000	24.0000	10.0000	24.0000
C113	19.0000	21.0000	15.0000	15.0000	13.0000
C115	18.0000	22.0000	18.0000	22.0000	20.0000
C116	6.0000	14.0000	10.0000	26.0000	16.0000
C117	10.0000	14.0000	10.0000	24.0000	6.0000
C118	12.0000	12.0000	8.0000	22.0000	6.0000
C119	26.0000	26.0000	26.0000	26.0000	26.0000
C120	16.0000	22.0000	18.0000	18.0000	20.0000
C121	10.0000	16.0000	14.0000	24.0000	16.0000
C122	21.0000	17.0000	25.0000	17.0000	27.0000
C123	8.0000	16.0000	8.0000	22.0000	10.0000
C124	18.0000	20.0000	22.0000	18.0000	24.0000
C125	14.0000	12.0000	8.0000	14.0000	8.0000
C126	26.0000	22.0000	20.0000	10.0000	18.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C28	C29	C30	C31	C32
C128	16.0000	16.0000	14.0000	14.0000	10.0000
C129	28.0000	24.0000	26.0000	18.0000	22.0000
C130	16.0000	14.0000	12.0000	20.0000	16.0000
C132	12.0000	18.0000	14.0000	12.0000	18.0000

Client	C33	C34	C35	C36	C37
C34	27.0000				
C35	22.0000	23.0000			
C36	24.0000	25.0000	8.0000		
C37	20.0000	17.0000	26.0000	22.0000	
C38	14.0000	29.0000	16.0000	20.0000	24.0000
C39	18.0000	19.0000	12.0000	12.0000	16.0000
C40	12.0000	23.0000	10.0000	12.0000	20.0000
C41	14.0000	27.0000	16.0000	14.0000	20.0000
C42	14.0000	25.0000	28.0000	22.0000	10.0000
C44	14.0000	21.0000	14.0000	12.0000	16.0000
C46	22.0000	19.0000	14.0000	14.0000	14.0000
C47	22.0000	21.0000	18.0000	14.0000	22.0000
C49	20.0000	19.0000	10.0000	8.0000	20.0000
C50	16.0000	17.0000	14.0000	12.0000	16.0000
C51	18.0000	25.0000	12.0000	14.0000	18.0000
C52	14.0000	17.0000	12.0000	14.0000	18.0000
C53	8.0000	29.0000	18.0000	16.0000	24.0000
C55	12.0000	23.0000	12.0000	12.0000	20.0000
C57	18.0000	23.0000	8.0000	8.0000	20.0000
C58	16.0000	19.0000	24.0000	22.0000	12.0000
C59	22.0000	29.0000	16.0000	8.0000	20.0000
C60	26.0000	19.0000	10.0000	12.0000	28.0000
C61	28.0000	21.0000	24.0000	18.0000	20.0000
C62	24.0000	25.0000	18.0000	12.0000	12.0000
C63	18.0000	23.0000	8.0000	8.0000	20.0000
C64	22.0000	19.0000	22.0000	16.0000	14.0000
C65	15.0000	18.0000	13.0000	19.0000	19.0000
C66	24.0000	15.0000	16.0000	18.0000	24.0000
C67	16.0000	23.0000	8.0000	12.0000	24.0000
C69	14.0000	19.0000	16.0000	18.0000	16.0000
C70	16.0000	17.0000	12.0000	14.0000	18.0000
C71	16.0000	21.0000	28.0000	26.0000	18.0000
C72	14.0000	33.0000	20.0000	14.0000	24.0000
C73	25.0000	24.0000	21.0000	23.0000	27.0000
C74	20.0000	19.0000	18.0000	16.0000	18.0000
C75	16.0000	19.0000	16.0000	18.0000	22.0000
C76	20.0000	19.0000	12.0000	12.0000	20.0000
C78	16.0000	29.0000	28.0000	24.0000	18.0000
C79	22.0000	19.0000	8.0000	10.0000	22.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C33	C34	C35	C36	C37
C80	22.0000	29.0000	14.0000	6.0000	24.0000
C81	26.0000	21.0000	18.0000	20.0000	24.0000
C82	24.0000	15.0000	16.0000	10.0000	16.0000
C83	24.0000	19.0000	16.0000	20.0000	16.0000
C84	12.0000	23.0000	10.0000	12.0000	20.0000
C85	30.0000	13.0000	16.0000	18.0000	24.0000
C86	20.0000	21.0000	14.0000	14.0000	22.0000
C87	24.0000	19.0000	6.0000	10.0000	26.0000
C89	24.0000	17.0000	14.0000	16.0000	22.0000
C90	10.0000	21.0000	20.0000	22.0000	16.0000
C91	22.0000	13.0000	18.0000	14.0000	14.0000
C92	22.0000	21.0000	8.0000	6.0000	20.0000
C93	20.0000	21.0000	20.0000	16.0000	18.0000
C94	24.0000	11.0000	16.0000	20.0000	20.0000
C95	12.0000	25.0000	22.0000	18.0000	16.0000
C96	22.0000	11.0000	18.0000	22.0000	14.0000
C97	24.0000	25.0000	14.0000	8.0000	14.0000
C98	22.0000	11.0000	14.0000	20.0000	22.0000
C99	26.0000	27.0000	24.0000	18.0000	16.0000
C102	18.0000	33.0000	20.0000	18.0000	28.0000
C103	24.0000	21.0000	10.0000	4.0000	22.0000
C104	16.0000	17.0000	16.0000	16.0000	16.0000
C106	26.0000	23.0000	10.0000	10.0000	28.0000
C107	14.0000	25.0000	26.0000	22.0000	20.0000
C108	18.0000	21.0000	16.0000	16.0000	16.0000
C109	16.0000	23.0000	8.0000	10.0000	22.0000
C110	26.0000	25.0000	20.0000	16.0000	20.0000
C112	22.0000	19.0000	24.0000	20.0000	18.0000
C113	13.0000	20.0000	19.0000	19.0000	15.0000
C115	26.0000	19.0000	18.0000	14.0000	18.0000
C116	16.0000	25.0000	20.0000	16.0000	22.0000
C117	18.0000	27.0000	14.0000	14.0000	24.0000
C118	16.0000	19.0000	10.0000	12.0000	16.0000
C119	32.0000	17.0000	22.0000	20.0000	16.0000
C120	26.0000	17.0000	20.0000	14.0000	14.0000
C121	12.0000	27.0000	22.0000	18.0000	22.0000
C122	19.0000	26.0000	21.0000	21.0000	27.0000
C123	16.0000	21.0000	16.0000	12.0000	14.0000
C124	16.0000	31.0000	26.0000	20.0000	24.0000
C125	18.0000	19.0000	8.0000	10.0000	22.0000
C126	16.0000	25.0000	16.0000	20.0000	24.0000
C128	18.0000	19.0000	14.0000	14.0000	16.0000
C129	28.0000	19.0000	18.0000	20.0000	28.0000
C130	20.0000	21.0000	14.0000	12.0000	16.0000
C132	26.0000	21.0000	12.0000	6.0000	20.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C38	C39	C40	C41	C42
C39	20.0000				
C40	20.0000	10.0000			
C41	14.0000	14.0000	16.0000		
C42	22.0000	20.0000	18.0000	14.0000	
C44	24.0000	12.0000	10.0000	16.0000	18.0000
C46	22.0000	14.0000	12.0000	20.0000	18.0000
C47	24.0000	10.0000	16.0000	18.0000	24.0000
C49	22.0000	6.0000	8.0000	14.0000	22.0000
C50	24.0000	6.0000	8.0000	18.0000	20.0000
C51	16.0000	8.0000	14.0000	12.0000	20.0000
C52	22.0000	8.0000	6.0000	20.0000	22.0000
C53	12.0000	22.0000	18.0000	10.0000	18.0000
C55	22.0000	12.0000	6.0000	16.0000	20.0000
C57	20.0000	6.0000	6.0000	10.0000	20.0000
C58	24.0000	12.0000	18.0000	20.0000	18.0000
C59	14.0000	16.0000	18.0000	12.0000	16.0000
C60	20.0000	14.0000	16.0000	24.0000	30.0000
C61	20.0000	20.0000	26.0000	24.0000	24.0000
C62	18.0000	18.0000	22.0000	16.0000	14.0000
C63	20.0000	6.0000	6.0000	10.0000	20.0000
C64	30.0000	16.0000	14.0000	24.0000	16.0000
C65	23.0000	15.0000	7.0000	23.0000	21.0000
C66	26.0000	12.0000	16.0000	24.0000	28.0000
C67	14.0000	12.0000	8.0000	10.0000	20.0000
C69	18.0000	8.0000	14.0000	14.0000	22.0000
C70	24.0000	10.0000	6.0000	20.0000	20.0000
C71	26.0000	22.0000	20.0000	26.0000	20.0000
C72	16.0000	20.0000	22.0000	12.0000	16.0000
C73	19.0000	29.0000	27.0000	25.0000	25.0000
C74	26.0000	12.0000	16.0000	16.0000	20.0000
C75	22.0000	20.0000	14.0000	18.0000	18.0000
C76	20.0000	14.0000	14.0000	18.0000	22.0000
C78	24.0000	18.0000	20.0000	18.0000	16.0000
C79	14.0000	12.0000	12.0000	20.0000	26.0000
C80	18.0000	16.0000	14.0000	12.0000	18.0000
C81	30.0000	22.0000	18.0000	24.0000	22.0000
C82	28.0000	14.0000	14.0000	20.0000	18.0000
C83	20.0000	26.0000	22.0000	22.0000	20.0000
C84	20.0000	10.0000	.0000	16.0000	18.0000
C85	30.0000	20.0000	20.0000	28.0000	26.0000
C86	22.0000	6.0000	12.0000	18.0000	24.0000
C87	18.0000	12.0000	12.0000	20.0000	28.0000
C89	22.0000	22.0000	18.0000	22.0000	22.0000
C90	22.0000	14.0000	12.0000	20.0000	20.0000
C91	28.0000	14.0000	12.0000	22.0000	16.0000
C92	18.0000	6.0000	10.0000	12.0000	22.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C38	C39	C40	C41	C42
C93	30.0000	12.0000	12.0000	24.0000	20.0000
C94	20.0000	20.0000	22.0000	26.0000	24.0000
C95	16.0000	18.0000	18.0000	12.0000	12.0000
C96	24.0000	16.0000	18.0000	26.0000	20.0000
C97	18.0000	10.0000	16.0000	18.0000	18.0000
C98	26.0000	14.0000	14.0000	26.0000	26.0000
C99	22.0000	24.0000	26.0000	18.0000	14.0000
C102	12.0000	22.0000	20.0000	18.0000	24.0000
C103	20.0000	10.0000	12.0000	16.0000	22.0000
C104	24.0000	12.0000	14.0000	16.0000	18.0000
C106	24.0000	16.0000	16.0000	22.0000	28.0000
C107	22.0000	18.0000	16.0000	16.0000	16.0000
C108	20.0000	4.0000	14.0000	14.0000	20.0000
C109	16.0000	10.0000	6.0000	10.0000	20.0000
C110	26.0000	18.0000	24.0000	20.0000	20.0000
C112	24.0000	20.0000	24.0000	22.0000	20.0000
C113	21.0000	11.0000	13.0000	17.0000	21.0000
C115	24.0000	16.0000	18.0000	24.0000	24.0000
C116	26.0000	20.0000	12.0000	16.0000	12.0000
C117	22.0000	12.0000	8.0000	16.0000	20.0000
C118	18.0000	8.0000	6.0000	16.0000	22.0000
C119	26.0000	24.0000	26.0000	30.0000	24.0000
C120	26.0000	14.0000	18.0000	22.0000	16.0000
C121	22.0000	14.0000	12.0000	12.0000	14.0000
C122	13.0000	29.0000	27.0000	17.0000	19.0000
C123	20.0000	10.0000	6.0000	16.0000	16.0000
C124	22.0000	24.0000	24.0000	12.0000	16.0000
C125	20.0000	8.0000	6.0000	16.0000	24.0000
C126	10.0000	18.0000	20.0000	22.0000	28.0000
C128	20.0000	2.0000	12.0000	14.0000	20.0000
C129	22.0000	20.0000	24.0000	26.0000	32.0000
C130	22.0000	16.0000	14.0000	18.0000	18.0000
C132	22.0000	14.0000	16.0000	18.0000	20.0000

Client	C44	C46	C47	C49	C50
C46	14.0000				
C47	16.0000	18.0000			
C49	12.0000	10.0000	8.0000		
C50	10.0000	12.0000	10.0000	4.0000	
C51	14.0000	16.0000	12.0000	10.0000	14.0000
C52	10.0000	10.0000	12.0000	6.0000	2.0000
C53	14.0000	20.0000	24.0000	20.0000	22.0000
C55	4.0000	14.0000	18.0000	12.0000	10.0000
C57	10.0000	14.0000	14.0000	6.0000	8.0000
C58	14.0000	20.0000	12.0000	14.0000	10.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C44	C46	C47	C49	C50
C59	16.0000	20.0000	18.0000	16.0000	20.0000
C60	22.0000	18.0000	12.0000	10.0000	12.0000
C61	22.0000	20.0000	16.0000	18.0000	18.0000
C62	14.0000	14.0000	22.0000	18.0000	20.0000
C63	10.0000	14.0000	14.0000	6.0000	8.0000
C64	16.0000	16.0000	18.0000	16.0000	12.0000
C65	13.0000	15.0000	19.0000	15.0000	11.0000
C66	20.0000	20.0000	8.0000	12.0000	12.0000
C67	14.0000	14.0000	20.0000	12.0000	14.0000
C69	12.0000	18.0000	14.0000	12.0000	12.0000
C70	8.0000	8.0000	14.0000	6.0000	4.0000
C71	20.0000	24.0000	18.0000	24.0000	20.0000
C72	18.0000	26.0000	20.0000	20.0000	22.0000
C73	25.0000	27.0000	27.0000	27.0000	29.0000
C74	10.0000	16.0000	8.0000	10.0000	10.0000
C75	10.0000	16.0000	26.0000	20.0000	18.0000
C76	10.0000	8.0000	16.0000	10.0000	12.0000
C78	20.0000	28.0000	16.0000	22.0000	18.0000
C79	18.0000	10.0000	14.0000	8.0000	10.0000
C80	16.0000	16.0000	16.0000	12.0000	16.0000
C81	20.0000	20.0000	22.0000	20.0000	20.0000
C82	12.0000	10.0000	18.0000	12.0000	12.0000
C83	18.0000	14.0000	28.0000	24.0000	26.0000
C84	10.0000	12.0000	16.0000	8.0000	8.0000
C85	22.0000	16.0000	16.0000	14.0000	16.0000
C86	16.0000	16.0000	6.0000	10.0000	10.0000
C87	18.0000	14.0000	14.0000	6.0000	10.0000
C89	14.0000	14.0000	26.0000	20.0000	22.0000
C90	12.0000	18.0000	14.0000	16.0000	12.0000
C91	14.0000	10.0000	16.0000	10.0000	8.0000
C92	14.0000	10.0000	12.0000	4.0000	8.0000
C93	14.0000	16.0000	12.0000	12.0000	8.0000
C94	18.0000	14.0000	20.0000	18.0000	18.0000
C95	12.0000	18.0000	24.0000	20.0000	20.0000
C96	16.0000	10.0000	20.0000	16.0000	14.0000
C97	18.0000	12.0000	14.0000	12.0000	14.0000
C98	16.0000	12.0000	16.0000	12.0000	10.0000
C99	22.0000	22.0000	24.0000	24.0000	26.0000
C102	24.0000	26.0000	16.0000	20.0000	24.0000
C103	16.0000	12.0000	10.0000	4.0000	8.0000
C104	6.0000	12.0000	14.0000	10.0000	10.0000
C106	18.0000	16.0000	10.0000	10.0000	12.0000
C107	20.0000	28.0000	18.0000	20.0000	18.0000
C108	14.0000	18.0000	8.0000	10.0000	10.0000
C109	12.0000	12.0000	18.0000	10.0000	12.0000
C110	18.0000	20.0000	12.0000	16.0000	18.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C44	C46	C47	C49	C50
C112	20.0000	20.0000	14.0000	16.0000	18.0000
C113	11.0000	19.0000	11.0000	11.0000	9.0000
C115	22.0000	10.0000	16.0000	14.0000	14.0000
C116	16.0000	16.0000	22.0000	18.0000	16.0000
C117	16.0000	18.0000	12.0000	12.0000	12.0000
C118	12.0000	12.0000	16.0000	10.0000	8.0000
C119	26.0000	16.0000	24.0000	24.0000	24.0000
C120	18.0000	8.0000	12.0000	10.0000	10.0000
C121	16.0000	24.0000	14.0000	16.0000	14.0000
C122	25.0000	25.0000	29.0000	27.0000	29.0000
C123	14.0000	14.0000	16.0000	10.0000	8.0000
C124	18.0000	24.0000	20.0000	22.0000	24.0000
C125	12.0000	8.0000	10.0000	2.0000	6.0000
C126	20.0000	20.0000	18.0000	18.0000	18.0000
C128	12.0000	16.0000	8.0000	8.0000	8.0000
C129	26.0000	26.0000	12.0000	18.0000	20.0000
C130	8.0000	6.0000	20.0000	14.0000	16.0000
C132	14.0000	10.0000	14.0000	8.0000	10.0000

Client	C51	C52	C53	C55	C57
C52	14.0000				
C53	16.0000	20.0000			
C55	16.0000	8.0000	12.0000		
C57	12.0000	10.0000	18.0000	8.0000	
C58	12.0000	12.0000	22.0000	18.0000	18.0000
C59	14.0000	22.0000	14.0000	16.0000	14.0000
C60	16.0000	12.0000	26.0000	20.0000	16.0000
C61	20.0000	20.0000	26.0000	26.0000	24.0000
C62	14.0000	22.0000	16.0000	18.0000	18.0000
C63	12.0000	10.0000	18.0000	8.0000	.0000
C64	24.0000	14.0000	28.0000	18.0000	16.0000
C65	19.0000	9.0000	23.0000	11.0000	13.0000
C66	18.0000	12.0000	28.0000	18.0000	16.0000
C67	16.0000	12.0000	14.0000	10.0000	6.0000
C69	8.0000	12.0000	18.0000	14.0000	12.0000
C70	14.0000	2.0000	20.0000	8.0000	10.0000
C71	22.0000	20.0000	24.0000	22.0000	24.0000
C72	16.0000	24.0000	8.0000	18.0000	18.0000
C73	25.0000	29.0000	21.0000	25.0000	25.0000
C74	12.0000	12.0000	20.0000	14.0000	12.0000
C75	24.0000	16.0000	14.0000	8.0000	16.0000
C76	14.0000	10.0000	14.0000	10.0000	14.0000
C78	18.0000	20.0000	22.0000	20.0000	20.0000
C79	14.0000	8.0000	20.0000	16.0000	14.0000
C80	18.0000	18.0000	14.0000	14.0000	10.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C51	C52	C53	C55	C57
C81	26.0000	20.0000	26.0000	18.0000	16.0000
C82	20.0000	12.0000	20.0000	12.0000	12.0000
C83	22.0000	24.0000	18:0000	18.0000	22.0000
C84	14.0000	6.0000	18.0000	6.0000	6.0000
C85	20.0000	16.0000	28.0000	22.0000	20.0000
C86	12.0000	10.0000	24.0000	14.0000	10.0000
C87	14.0000	10.0000	22.0000	16.0000	12.0000
C89	22.0000	20.0000	16.0000	12.0000	18.0000
C90	12.0000	10.0000	18.0000	12.0000	18.0000
C91	20.0000	8.0000	24.0000	14.0000	14.0000
C92	8.0000	10.0000	18.0000	14.0000	6.0000
C93	18.0000	10.0000	28.0000	16.0000	14.0000
C94	20.0000	16.0000	22.0000	20.0000	24.0000
C95	16.0000	20.0000	8.0000	14.0000	16.0000
C96	22.0000	12.0000	24.0000	16.0000	20.0000
C97	14.0000	16.0000	22.0000	18.0000	14.0000
C98	18.0000	8.0000	26.0000	16.0000	16.0000
C99	20.0000	28.0000	20.0000	24.0000	22.0000
C102	16.0000	24.0000	16.0000	22.0000	20.0000
C103	12.0000	10.0000	20.0000	16.0000	10.0000
C104	12.0000	10.0000	16.0000	10.0000	12.0000
C106	16.0000	12.0000	22.0000	16.0000	14.0000
C107	20.0000	20.0000	22.0000	20.0000	18.0000
C108	6.0000	12.0000	22.0000	16.0000	10.0000
C109	14.0000	10.0000	14.0000	8.0000	4.0000
C110	12.0000	20.0000	22.0000	22.0000	20.0000
C112	14.0000	20.0000	20.0000	24.0000	22.0000
C113	9.0000	9.0000	19.0000	13.0000	15.0000
C115	20.0000	14.0000	24.0000	20.0000	18.0000
C116	26.0000	16.0000	18.0000	14.0000	14.0000
C117	16.0000	12.0000	22.0000	12.0000	8.0000
C118	14.0000	6.0000	20.0000	10.0000	8.0000
C119	28.0000	24.0000	30.0000	26.0000	26.0000
C120	20.0000	12.0000	26.0000	20.0000	16.0000
C121	20.0000	16.0000	20.0000	16.0000	14.0000
C122	25.0000	29.0000	13.0000	25.0000	25.0000
C123	18.0000	10.0000	22.0000	12.0000	8.0000
C124	20.0000	26.0000	12.0000	20.0000	20.0000
C125	10.0000	4.0000	18.0000	10.0000	8.0000
C126	12.0000	16.0000	16.0000	20.0000	22.0000
C128	6.0000	10.0000	22.0000	14.0000	8.0000
C129	18.0000	20.0000	28.0000	26.0000	24.0000
C130	18.0000	14.0000	14.0000	8.0000	14.0000
C132	16.0000	12.0000	20.0000	16.0000	12.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C58	C59	C60	C61	C62
C59	22.0000				
C60	20.0000	18.0000			
C61	18.0000	16.0000	18.0000		
C62	18.0000	8.0000	22.0000	16.0000	
C63	18.0000	14.0000	16.0000	24.0000	18.0000
C64	18.0000	24.0000	22.0000	16.0000	22.0000
C65	15.0000	25.0000	15.0000	25.0000	25.0000
C66	14.0000	24.0000	10.0000	20.0000	28.0000
C67	24.0000	16.0000	18.0000	28.0000	22.0000
C69	12.0000	20.0000	20.0000	18.0000	20.0000
C70	12.0000	22.0000	14.0000	20.0000	20.0000
C71	12.0000	28.0000	26.0000	22.0000	24.0000
C72	20.0000	10.0000	24.0000	22.0000	14.0000
C73	27.0000	21.0000	21.0000	21.0000	19.0000
C74	8.0000	18.0000	18.0000	18.0000	16.0000
C75	24.0000	20.0000	22.0000	30.0000	20.0000
C76	18.0000	16.0000	16.0000	16.0000	14.0000
C78	12.0000	20.0000	26.0000	20.0000	24.0000
C79	20.0000	16.0000	8.0000	16.0000	18.0000
C80	26.0000	8.0000	18.0000	20.0000	16.0000
C81	26.0000	24.0000	20.0000	26.0000	26.0000
C82	20.0000	18.0000	18.0000	22.0000	16.0000
C83	28.0000	18.0000	22.0000	24.0000	14.0000
C84	18.0000	18.0000	16.0000	26.0000	22.0000
C85	22.0000	26.0000	10.0000	22.0000	24.0000
C86	14.0000	20.0000	12.0000	22.0000	24.0000
C87	20.0000	16.0000	4.0000	18.0000	18.0000
C89	28.0000	18.0000	20.0000	26.0000	16.0000
C90	8.0000	24.0000	20.0000	22.0000	22.0000
C91	16.0000	22.0000	16.0000	20.0000	20.0000
C92	18.0000	14.0000	12.0000	18.0000	16.0000
C93	12.0000	24.0000	16.0000	16.0000	24.0000
C94	22.0000	22.0000	14.0000	18.0000	18.0000
C95	16.0000	14.0000	30.0000	26.0000	12.0000
C96	18.0000	26.0000	18.0000	20.0000	20.0000
C97	20.0000	10.0000	14.0000	16.0000	12.0000
C98	16.0000	28.0000	10.0000	24.0000	24.0000
C99	24.0000	12.0000	28.0000	16.0000	12.0000
C102	20.0000	14.0000	18.0000	20.0000	20.0000
C103	18.0000	12.0000	8.0000	14.0000	16.0000
C104	12.0000	18.0000	20.0000	18.0000	14.0000
C106	18.0000	18.0000	8.0000	18.0000	20.0000
C107	18.0000	20.0000	26.0000	20.0000	26.0000
C108	8.0000	16.0000	16.0000	20.0000	18.0000
C109	22.0000	14.0000	18.0000	26.0000	20.0000
C110	12.0000	16.0000	18.0000	14.0000	12.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C58	C59	C60	C61	C62
C112	14.0000	22.0000	20.0000	18.0000	18.0000
C113	7.0000	21.0000	17.0000	19.0000	21.0000
C115	22.0000	20.0000	16.0000	14.0000	20.0000
C116	24.0000	20.0000	24.0000	24.0000	22.0000
C117	18.0000	18.0000	16.0000	26.0000	26.0000
C118	16.0000	20.0000	16.0000	22.0000	22.0000
C119	28.0000	24.0000	22.0000	14.0000	20.0000
C120	18.0000	20.0000	16.0000	14.0000	16.0000
C121	20.0000	18.0000	22.0000	22.0000	26.0000
C122	27.0000	15.0000	21.0000	23.0000	17.0000
C123	16.0000	16.0000	18.0000	20.0000	20.0000
C124	20.0000	18.0000	28.0000	24.0000	18.0000
C125	16.0000	18.0000	10.0000	20.0000	20.0000
C126	16.0000	20.0000	14.0000	18.0000	18.0000
C128	10.0000	16.0000	14.0000	20.0000	18.0000
C129	18.0000	20.0000	10.0000	12.0000	24.0000
C130	22.0000	16.0000	22.0000	22.0000	10.0000
C132	18.0000	12.0000	12.0000	12.0000	12.0000

Client	C63	C64	C65	C66	C67
C64	16.0000				
C65	13.0000	13.0000			
C66	16.0000	20.0000	13.0000		
C67	6.0000	20.0000	13.0000	18.0000	
C69	12.0000	20.0000	17.0000	14.0000	16.0000
C70	*10.0000*	*14.0000*	*9.0000*	*14.0000*	*12.0000*
C71	24.0000	16.0000	17.0000	18.0000	28.0000
C72	18.0000	26.0000	27.0000	28.0000	20.0000
C73	25.0000	25.0000	26.0000	29.0000	27.0000
C74	12.0000	20.0000	17.0000	12.0000	18.0000
C75	16.0000	20.0000	13.0000	22.0000	10.0000
C76	14.0000	20.0000	17.0000	18.0000	14.0000
C78	20.0000	16.0000	19.0000	20.0000	22.0000
C79	14.0000	20.0000	15.0000	14.0000	12.0000
C80	10.0000	18.0000	21.0000	22.0000	10.0000
C81	16.0000	14.0000	15.0000	20.0000	16.0000
C82	12.0000	12.0000	17.0000	18.0000	14.0000
C83	22.0000	26.0000	21.0000	28.0000	20.0000
C84	6.0000	14.0000	7.0000	16.0000	8.0000
C85	20.0000	18.0000	17.0000	16.0000	22.0000
C86	10.0000	18.0000	15.0000	6.0000	14.0000
C87	12.0000	22.0000	15.0000	12.0000	14.0000
C89	18.0000	22.0000	17.0000	24.0000	16.0000
C90	18.0000	18.0000	11.0000	14.0000	20.0000
C91	14.0000	10.0000	15.0000	16.0000	16.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C63	C64	C65	C66	C67
C92	6.0000	16.0000	17.0000	16.0000	10.0000
C93	14.0000	6.0000	9.0000	14.0000	20.0000
C94	24.0000	22.0000	19.0000	20.0000	22.0000
C95	16.0000	22.0000	21.0000	28.0000	14.0000
C96	20.0000	16.0000	13.0000	14.0000	18.0000
C97	14.0000	18.0000	21.0000	18.0000	18.0000
C98	16.0000	18.0000	9.0000	12.0000	16.0000
C99	22.0000	18.0000	29.0000	32.0000	24.0000
C102	20.0000	28.0000	25.0000	22.0000	22.0000
C103	10.0000	16.0000	19.0000	14.0000	14.0000
C104	12.0000	18.0000	17.0000	18.0000	16.0000
C106	14.0000	20.0000	17.0000	12.0000	16.0000
C107	18.0000	16.0000	19.0000	20.0000	20.0000
C108	10.0000	20.0000	17.0000	12.0000	16.0000
C109	4.0000	18.0000	13.0000	18.0000	2.0000
C110	20.0000	20.0000	25.0000	20.0000	26.0000
C112	22.0000	20.0000	25.0000	22.0000	28.0000
C113	15.0000	19.0000	14.0000	13.0000	19.0000
C115	18.0000	16.0000	19.0000	16.0000	20.0000
C116	14.0000	10.0000	15.0000	24.0000	12.0000
C117	8.0000	16.0000	13.0000	14.0000	10.0000
C118	8.0000	12.0000	9.0000	14.0000	8.0000
C119	26.0000	14.0000	23.0000	22.0000	26.0000
C120	16.0000	10.0000	19.0000	18.0000	20.0000
C121	14.0000	14.0000	17.0000	20.0000	16.0000
C122	25.0000	31.0000	26.0000	29.0000	21.0000
C123	8.0000	10.0000	9.0000	16.0000	12.0000
C124	20.0000	22.0000	25.0000	28.0000	22.0000
C125	8.0000	18.0000	13.0000	12.0000	10.0000
C126	22.0000	28.0000	19.0000	20.0000	22.0000
C128	8.0000	18.0000	15.0000	12.0000	14.0000
C129	24.0000	24.0000	21.0000	10.0000	26.0000
C130	14.0000	18.0000	17.0000	22.0000	14.0000
C132	12.0000	16.0000	19.0000	18.0000	16.0000

Client	C69	C70	C71	C72	C73
C70	14.0000				
C71	18.0000	20.0000			
C72	22.0000	24.0000	22.0000		
C73	29.0000	27.0000	23.0000	17.0000	
C74	14.0000	10.0000	18.0000	20.0000	25.0000
C75	22.0000	14.0000	26.0000	22.0000	23.0000
C76	16.0000	8.0000	26.0000	22.0000	25.0000
C78	18.0000	22.0000	16.0000	16.0000	27.0000
C79	16.0000	10.0000	28.0000	24.0000	27.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C69	C70	C71	C72	C73
C80	22.0000	18.0000	28.0000	12.0000	25.0000
C81	28.0000	18.0000	24.0000	24.0000	19.0000
C82	20.0000	10.0000	22.0000	22.0000	23.0000
C83	24.0000	22.0000	30.0000	24.0000	17.0000
C84	14.0000	6.0000	20.0000	22.0000	27.0000
C85	26.0000	14.0000	24.0000	26.0000	17.0000
C86	12.0000	12.0000	18.0000	24.0000	29.0000
C87	18.0000	10.0000	28.0000	22.0000	21.0000
C89	24.0000	18.0000	30.0000	24.0000	17.0000
C90	8.0000	12.0000	12.0000	24.0000	29.0000
C91	20.0000	6.0000	20.0000	26.0000	25.0000
C92	12.0000	10.0000	26.0000	20.0000	27.0000
C93	16.0000	10.0000	14.0000	24.0000	27.0000
C94	20.0000	16.0000	28.0000	28.0000	19.0000
C95	18.0000	18.0000	20.0000	10.0000	21.0000
C96	16.0000	12.0000	24.0000	32.0000	27.0000
C97	18.0000	18.0000	26.0000	18.0000	27.0000
C98	18.0000	8.0000	22.0000	30.0000	23.0000
C99	26.0000	26.0000	26.0000	14.0000	17.0000
C102	22.0000	24.0000	18.0000	12.0000	15.0000
C103	16.0000	10.0000	26.0000	18.0000	25.0000
C104	10.0000	8.0000	20.0000	20.0000	23.0000
C106	22.0000	12.0000	22.0000	18.0000	21.0000
C107	14.0000	22.0000	12.0000	18.0000	27.0000
C108	8.0000	14.0000	18.0000	20.0000	29.0000
C109	14.0000	10.0000	26.0000	20.0000	27.0000
C110	20.0000	18.0000	18.0000	14.0000	17.0000
C112	20.0000	18.0000	16.0000	16.0000	17.0000
C113	5.0000	11.0000	17.0000	23.0000	30.0000
C115	18.0000	16.0000	20.0000	24.0000	29.0000
C116	26.0000	14.0000	20.0000	18.0000	23.0000
C117	18.0000	12.0000	18.0000	20.0000	27.0000
C118	10.0000	8.0000	20.0000	26.0000	31.0000
C119	26.0000	24.0000	24.0000	28.0000	23.0000
C120	20.0000	12.0000	22.0000	24.0000	25.0000
C121	18.0000	18.0000	20.0000	16.0000	27.0000
C122	29.0000	27.0000	27.0000	13.0000	12.0000
C123	14.0000	12.0000	20.0000	24.0000	31.0000
C124	24.0000	24.0000	18.0000	8.0000	17.0000
C125	12.0000	4.0000	24.0000	22.0000	27.0000
C126	16.0000	18.0000	20.0000	18.0000	17.0000
C128	8.0000	12.0000	20.0000	20.0000	29.0000
C129	18.0000	22.0000	18.0000	24.0000	21.0000
C130	18.0000	12.0000	24.0000	22.0000	25.0000
C132	20.0000	10.0000	26.0000	18.0000	23.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C74	C75	C76	C78	C79
C75	20.0000				
C76	12.0000	14.0000			
C78	18.0000	24.0000	28.0000		
C79	18.0000	20.0000	8.0000	28.0000	
C80	20.0000	16.0000	14.0000	20.0000	14.0000
C81	20.0000	16.0000	22.0000	18.0000	24.0000
C82	14.0000	14.0000	12.0000	26.0000	16.0000
C83	22.0000	14.0000	14.0000	32.0000	18.0000
C84	16.0000	14.0000	14.0000	20.0000	12.0000
C85	18.0000	20.0000	16.0000	28.0000	16.0000
C86	10.0000	22.0000	16.0000	18.0000	14.0000
C87	16.0000	20.0000	12.0000	28.0000	6.0000
C89	22.0000	8.0000	10.0000	32.0000	16.0000
C90	12.0000	20.0000	16.0000	14.0000	18.0000
C91	14.0000	16.0000	12.0000	24.0000	14.0000
C92	14.0000	20.0000	10.0000	24.0000	8.0000
C93	14.0000	22.0000	18.0000	14.0000	18.0000
C94	20.0000	16.0000	10.0000	32.0000	10.0000
C95	16.0000	12.0000	18.0000	18.0000	24.0000
C96	18.0000	14.0000	10.0000	28.0000	12.0000
C97	20.0000	24.0000	14.0000	22.0000	10.0000
C98	14.0000	14.0000	14.0000	26.0000	12.0000
C99	22.0000	24.0000	20.0000	16.0000	24.0000
C102	20.0000	28.0000	24.0000	18.0000	22.0000
C103	14.0000	22.0000	10.0000	24.0000	6.0000
C104	6.0000	14.0000	8.0000	22.0000	16.0000
C106	12.0000	22.0000	12.0000	22.0000	10.0000
C107	22.0000	24.0000	28.0000	10.0000	26.0000
C108	8.0000	24.0000	18.0000	14.0000	16.0000
C109	16.0000	12.0000	12.0000	22.0000	12.0000
C110	10.0000	26.0000	16.0000	16.0000	20.0000
C112	14.0000	28.0000	18.0000	22.0000	22.0000
C113	11.0000	21.0000	15.0000	15.0000	15.0000
C115	22.0000	26.0000	14.0000	24.0000	12.0000
C116	20.0000	12.0000	18.0000	18.0000	22.0000
C117	16.0000	18.0000	20.0000	14.0000	18.0000
C118	18.0000	16.0000	14.0000	20.0000	10.0000
C119	28.0000	26.0000	20.0000	26.0000	18.0000
C120	16.0000	22.0000	12.0000	24.0000	12.0000
C121	20.0000	20.0000	24.0000	12.0000	22.0000
C122	25.0000	19.0000	21.0000	27.0000	23.0000
C123	18.0000	18.0000	16.0000	18.0000	12.0000
C124	18.0000	20.0000	24.0000	16.0000	30.0000
C125	12.0000	18.0000	8.0000	24.0000	6.0000
C126	18.0000	26.0000	18.0000	24.0000	14.0000
C128	10.0000	22.0000	16.0000	16.0000	14.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C74	C75	C76	C78	C79
C129	18.0000	30.0000	22.0000	20.0000	16.0000
C130	16.0000	10.0000	6.0000	28.0000	14.0000
C132	12.0000	20.0000	6.0000	26.0000	8.0000

Client	C80	C81	C82	C83	C84
C81	18.0000				
C82	14.0000	12.0000			
C83	22.0000	20.0000	18.0000		
C84	14.0000	18.0000	14.0000	22.0000	
C85	20.0000	12.0000	12.0000	18.0000	20.0000
C86	18.0000	20.0000	14.0000	28.0000	12.0000
C87	16.0000	20.0000	16.0000	20.0000	12.0000
C89	16.0000	18.0000	14.0000	8.0000	18.0000
C90	26.0000	26.0000	20.0000	24.0000	12.0000
C91	18.0000	14.0000	4.0000	20.0000	12.0000
C92	10.0000	22.0000	12.0000	22.0000	10.0000
C93	18.0000	16.0000	14.0000	30.0000	12.0000
C94	24.0000	24.0000	18.0000	10.0000	22.0000
C95	16.0000	22.0000	16.0000	20.0000	18.0000
C96	24.0000	20.0000	14.0000	14.0000	18.0000
C97	12.0000	26.0000	18.0000	18.0000	16.0000
C98	24.0000	16.0000	14.0000	20.0000	14.0000
C99	16.0000	14.0000	18.0000	16.0000	26.0000
C102	18.0000	24.0000	26.0000	26.0000	20.0000
C103	10.0000	22.0000	12.0000	22.0000	12.0000
C104	20.0000	20.0000	12.0000	16.0000	14.0000
C106	14.0000	16.0000	14.0000	22.0000	16.0000
C107	18.0000	24.0000	26.0000	32.0000	16.0000
C108	20.0000	24.0000	18.0000	26.0000	14.0000
C109	10.0000	16.0000	12.0000	20.0000	6.0000
C110	20.0000	20.0000	18.0000	22.0000	24.0000
C112	22.0000	20.0000	16.0000	22.0000	24.0000
C113	23.0000	27.0000	21.0000	25.0000	13.0000
C115	14.0000	24.0000	16.0000	22.0000	18.0000
C116	12.0000	12.0000	12.0000	24.0000	12.0000
C117	12.0000	14.0000	16.0000	28.0000	8.0000
C118	16.0000	22.0000	14.0000	24.0000	6.0000
C119	22.0000	18.0000	18.0000	16.0000	26.0000
C120	14.0000	18.0000	10.0000	20.0000	18.0000
C121	14.0000	20.0000	22.0000	30.0000	12.0000
C122	19.0000	25.0000	25.0000	17.0000	27.0000
C123	12.0000	22.0000	16.0000	24.0000	6.0000
C124	16.0000	18.0000	20.0000	26.0000	24.0000
C125	14.0000	20.0000	12.0000	22.0000	6.0000
C126	26.0000	28.0000	24.0000	22.0000	20.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C80	C81	C82	C83	C84
C128	18.0000	22.0000	16.0000	26.0000	12.0000
C129	24.0000	24.0000	26.0000	26.0000	24.0000
C130	14.0000	20.0000	10.0000	12.0000	14.0000
C132	10.0000	20.0000	10.0000	18.0000	16.0000

Client	C85	C86	C87	C89	C90
C86	18.0000				
C87	12.0000	14.0000			
C89	14.0000	24.0000	18.0000		
C90	24.0000	12.0000	20.0000	24.0000	
C91	10.0000	14.0000	14.0000	18.0000	18.0000
C92	16.0000	10.0000	8.0000	18.0000	18.0000
C93	16.0000	12.0000	18.0000	26.0000	12.0000
C94	12.0000	22.0000	14.0000	8.0000	20.0000
C95	28.0000	24.0000	26.0000	18.0000	20.0000
C96	16.0000	18.0000	16.0000	12.0000	16.0000
C97	22.0000	14.0000	14.0000	20.0000	22.0000
C98	8.0000	14.0000	12.0000	14.0000	16.0000
C99	22.0000	28.0000	26.0000	20.0000	28.0000
C102	24.0000	18.0000	18.0000	28.0000	20.0000
C103	14.0000	12.0000	6.0000	20.0000	20.0000
C104	18.0000	16.0000	16.0000	16.0000	12.0000
C106	10.0000	12.0000	8.0000	20.0000	18.0000
C107	30.0000	20.0000	26.0000	32.0000	16.0000
C108	22.0000	6.0000	16.0000	26.0000	10.0000
C109	22.0000	12.0000	14.0000	16.0000	18.0000
C110	16.0000	18.0000	18.0000	24.0000	18.0000
C112	12.0000	20.0000	20.0000	24.0000	20.0000
C113	23.0000	13.0000	17.0000	25.0000	5.0000
C115	18.0000	16.0000	16.0000	22.0000	20.0000
C116	20.0000	20.0000	22.0000	20.0000	22.0000
C117	18.0000	8.0000	16.0000	24.0000	16.0000
C118	22.0000	10.0000	14.0000	20.0000	12.0000
C119	18.0000	24.0000	22.0000	20.0000	28.0000
C120	12.0000	16.0000	16.0000	18.0000	22.0000
C121	26.0000	16.0000	22.0000	28.0000	18.0000
C122	23.0000	29.0000	21.0000	17.0000	29.0000
C123	24.0000	14.0000	16.0000	20.0000	14.0000
C124	24.0000	24.0000	28.0000	24.0000	24.0000
C125	14.0000	10.0000	6.0000	18.0000	14.0000
C126	22.0000	18.0000	14.0000	24.0000	14.0000
C128	20.0000	6.0000	14.0000	24.0000	12.0000
C129	18.0000	16.0000	12.0000	28.0000	18.0000
C130	20.0000	18.0000	18.0000	8.0000	18.0000
C132	14.0000	16.0000	10.0000	16.0000	22.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C91	C92	C93	C94	C95
C92	12.0000				
C93	12.0000	14.0000			
C94	16.0000	18.0000	24.0000		
C95	20.0000	20.0000	24.0000	24.0000	
C96	12.0000	18.0000	18.0000	8.0000	22.0000
C97	18.0000	10.0000	18.0000	18.0000	22.0000
C98	12.0000	16.0000	14.0000	10.0000	22.0000
C99	20.0000	22.0000	24.0000	22.0000	16.0000
C102	26.0000	20.0000	24.0000	28.0000	20.0000
C103	10.0000	4.0000	14.0000	16.0000	22.0000
C104	12.0000	14.0000	16.0000	14.0000	12.0000
C106	14.0000	12.0000	14.0000	18.0000	26.0000
C107	24.0000	22.0000	14.0000	32.0000	20.0000
C108	18.0000	10.0000	14.0000	22.0000	18.0000
C109	14.0000	8.0000	18.0000	22.0000	14.0000
C110	18.0000	18.0000	16.0000	20.0000	18.0000
C112	14.0000	18.0000	18.0000	20.0000	18.0000
C113	17.0000	15.0000	13.0000	19.0000	19.0000
C115	16.0000	12.0000	14.0000	20.0000	28.0000
C116	12.0000	18.0000	12.0000	26.0000	16.0000
C117	14.0000	12.0000	12.0000	28.0000	22.0000
C118	12.0000	8.0000	12.0000	20.0000	20.0000
C119	18.0000	22.0000	20.0000	18.0000	30.0000
C120	8.0000	12.0000	12.0000	14.0000	22.0000
C121	20.0000	18.0000	12.0000	28.0000	20.0000
C122	27.0000	25.0000	31.0000	19.0000	17.0000
C123	14.0000	10.0000	10.0000	22.0000	20.0000
C124	24.0000	24.0000	20.0000	30.0000	10.0000
C125	10.0000	6.0000	14.0000	16.0000	20.0000
C126	24.0000	18.0000	22.0000	18.0000	20.0000
C128	16.0000	8.0000	12.0000	20.0000	18.0000
C129	24.0000	20.0000	18.0000	20.0000	32.0000
C130	14.0000	14.0000	20.0000	14.0000	14.0000
C132	10.0000	8.0000	14.0000	14.0000	20.0000

Client	C96	C97	C98	C99	C102
C97	18.0000				
C98	10.0000	22.0000			
C99	26.0000	18.0000	30.0000		
C102	32.0000	20.0000	28.0000	20.0000	
C103	18.0000	8.0000	16.0000	20.0000	18.0000
C104	12.0000	20.0000	12.0000	20.0000	24.0000
C106	20.0000	16.0000	14.0000	22.0000	16.0000
C107	28.0000	22.0000	28.0000	22.0000	20.0000
C108	20.0000	14.0000	16.0000	24.0000	18.0000
C109	18.0000	16.0000	16.0000	22.0000	20.0000
C110	24.0000	18.0000	20.0000	12.0000	16.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C96	C97	C98	C99	C102
C112	22.0000	22.0000	20.0000	16.0000	16.0000
C113	15.0000	19.0000	15.0000	27.0000	21.0000
C115	16.0000	10.0000	20.0000	24.0000	24.0000
C116	22.0000	22.0000	20.0000	18.0000	24.0000
C117	24.0000	18.0000	18.0000	24.0000	14.0000
C118	14.0000	14.0000	14.0000	28.0000	24.0000
C119	16.0000	14.0000	24.0000	16.0000	28.0000
C120	10.0000	12.0000	14.0000	18.0000	26.0000
C121	26.0000	18.0000	24.0000	22.0000	20.0000
C122	27.0000	23.0000	25.0000	19.0000	15.0000
C123	16.0000	12.0000	18.0000	24.0000	24.0000
C124	30.0000	26.0000	26.0000	16.0000	16.0000
C125	14.0000	14.0000	10.0000	26.0000	20.0000
C126	22.0000	20.0000	18.0000	26.0000	10.0000
C128	18.0000	12.0000	14.0000	24.0000	20.0000
C129	22.0000	20.0000	20.0000	26.0000	16.0000
C130	10.0000	14.0000	16.0000	20.0000	26.0000
C132	16.0000	10.0000	16.0000	16.0000	22.0000

Client	C103	C104	C106	C107	C108
C104	14.0000				
C106	8.0000	16.0000			
C107	22.0000	22.0000	26.0000		
C108	14.0000	12.0000	16.0000	18.0000	
C109	12.0000	14.0000	16.0000	20.0000	14.0000
C110	14.0000	12.0000	10.0000	22.0000	14.0000
C112	16.0000	14.0000	16.0000	24.0000	18.0000
C113	15.0000	9.0000	19.0000	15.0000	9.0000
C115	12.0000	22.0000	14.0000	20.0000	20.0000
C116	18.0000	18.0000	18.0000	16.0000	24.0000
C117	14.0000	20.0000	12.0000	16.0000	12.0000
C118	12.0000	16.0000	18.0000	18.0000	12.0000
C119	20.0000	26.0000	20.0000	26.0000	28.0000
C120	10.0000	14.0000	14.0000	24.0000	18.0000
C121	18.0000	20.0000	22.0000	8.0000	16.0000
C122	23.0000	25.0000	23.0000	27.0000	29.0000
C123	12.0000	18.0000	20.0000	14.0000	14.0000
C124	24.0000	18.0000	22.0000	18.0000	22.0000
C125	6.0000	10.0000	10.0000	22.0000	12.0000
C126	18.0000	18.0000	16.0000	26.0000	16.0000
C128	12.0000	12.0000	16.0000	18.0000	2.0000
C129	16.0000	22.0000	12.0000	18.0000	16.0000
C130	16.0000	10.0000	18.0000	28.0000	20.0000
C132	4.0000	12.0000	8.0000	26.0000	18.0000

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City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C109	C110	C112	C113	C115
C110	24.0000				
C112	26.0000	10.0000			
C113	17.0000	17.0000	17.0000		
C115	18.0000	22.0000	22.0000	21.0000	
C116	12.0000	20.0000	24.0000	25.0000	20.0000
C117	8.0000	20.0000	22.0000	17.0000	18.0000
C118	6.0000	26.0000	26.0000	11.0000	14.0000
C119	26.0000	22.0000	20.0000	29.0000	12.0000
C120	18.0000	16.0000	14.0000	19.0000	10.0000
C121	16.0000	22.0000	24.0000	17.0000	22.0000
C122	23.0000	23.0000	23.0000	30.0000	27.0000
C123	10.0000	26.0000	26.0000	13.0000	14.0000
C124	22.0000	14.0000	14.0000	23.0000	28.0000
C125	8.0000	18.0000	18.0000	11.0000	14.0000
C126	22.0000	18.0000	16.0000	15.0000	22.0000
C128	12.0000	16.0000	18.0000	9.0000	18.0000
C129	26.0000	14.0000	20.0000	17.0000	16.0000
C130	12.0000	20.0000	22.0000	19.0000	16.0000
C132	14.0000	12.0000	16.0000	19.0000	12.0000

Client	C116	C117	C118	C119	C120
C117	12.0000				
C118	16.0000	10.0000			
C119	22.0000	26.0000	22.0000		
C120	16.0000	18.0000	16.0000	14.0000	
C121	10.0000	12.0000	16.0000	26.0000	20.0000
C122	21.0000	27.0000	29.0000	27.0000	27.0000
C123	14.0000	12.0000	6.0000	22.0000	14.0000
C124	14.0000	20.0000	28.0000	28.0000	22.0000
C125	18.0000	12.0000	8.0000	24.0000	12.0000
C126	30.0000	24.0000	20.0000	26.0000	24.0000
C128	22.0000	12.0000	10.0000	26.0000	16.0000
C129	28.0000	20.0000	22.0000	20.0000	22.0000
C130	16.0000	20.0000	14.0000	18.0000	12.0000
C132	16.0000	18.0000	16.0000	18.0000	8.0000

Client	C121	C122	C123	C124	C125
C122	25.0000				
C123	12.0000	27.0000			
C124	14.0000	17.0000	26.0000		
C125	18.0000	27.0000	12.0000	24.0000	
C126	26.0000	17.0000	24.0000	22.0000	16.0000
C128	14.0000	29.0000	12.0000	22.0000	10.0000
C129	22.0000	25.0000	24.0000	26.0000	18.0000
C130	24.0000	23.0000	16.0000	20.0000	12.0000
C132	22.0000	19.0000	14.0000	22.0000	10.0000

**************PROXIMITIES**************

City Block Dissimilarity Coefficient Matrix (Cont.)

Client	C126	C128	C129	C130
C128	16.0000			
C129	16.0000	18.0000		
C130	22.0000	18.0000	28.0000	
C132	20.0000	16.0000	20.0000	12.0000

******HIERARCHICAL CLUSTER ANALYSIS******

Agglomeration Schedule using Average Linkage (Within Group)

	Clusters Combined:			Stage Cluster 1st Appears:		Next
Stage	Cluster 1	Cluster 2	Coefficient	Cluster 1	Cluster 2	Stage
1	38	75	.000000	0	0	3
2	50	56	.000000	0	0	13
3	28	38	1.333333	0	1	12
4	95	112	2.000000	0	0	9
5	44	110	2.000000	0	0	16
6	60	96	2.000000	0	0	13
7	47	62	2.000000	0	0	10
8	23	25	2.000000	0	0	11
9	37	95	2.666667	0	4	23
10	45	47	2.666667	0	7	27
11	7	23	2.666667	0	8	24
12	28	30	3.000000	3	0	25
13	50	60	3.666667	2	6	28
14	91	115	4.000000	0	0	37
15	14	108	4.000000	0	0	30
16	44	82	4.000000	5	0	29
17	73	81	4.000000	0	0	52
18	53	78	4.000000	0	0	40
19	15	71	4.000000	0	0	58
20	41	49	4.000000	0	0	55
21	9	34	4.000000	0	0	31
22	8	13	4.000000	0	0	48
23	37	77	4.333333	9	0	33
24	7	26	4.333333	11	0	43
25	28	103	4.400000	12	0	32
26	80	99	5.000000	0	0	39
27	21	45	5.000000	0	10	50
28	27	50	5.200000	0	13	44
29	4	44	5.333333	0	16	37
30	14	24	5.333333	15	0	73
31	9	20	5.333333	21	0	48
32	28	58	5.400000	25	0	45
33	37	46	5.800000	23	0	47
34	68	114	6.000000	0	0	46
35	1	106	6.000000	0	0	62
36	66	92	6.000000	0	0	72
37	4	91	6.000000	29	14	51
38	57	83	6.000000	0	0	79
39	61	80	6.000000	0	26	57
40	53	70	6.000000	18	0	53
41	11	59	6.000000	0	0	78
42	2	10	6.000000	0	0	54

******HIERARCHICAL CLUSTER ANALYSIS******

Agglomeration Schedule CONTINUED

Stage	Clusters Combined: Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears: Cluster 1	Cluster 2	Next Stage
43	3	7	6.000000	0	24	56
44	27	33	6.133333	28	0	59
45	17	28	6.190476	0	32	49
46	42	68	6.666667	0	34	69
47	37	43	6.800000	33	0	72
48	8	9	6.800000	22	31	58
49	17	102	6.892857	45	0	59
50	21	88	7.000000	27	0	79
51	4	87	7.142857	37	0	70
52	73	105	7.333333	17	0	65
53	53	93	7.333333	40	0	70
54	2	85	7.333333	42	0	77
55	41	67	7.333333	20	0	81
56	3	39	7.333333	43	0	71
57	51	61	7.500000	0	39	76
58	8	15	7.619048	48	19	80
59	17	27	7.989011	49	44	73
60	64	109	8.000000	0	0	89
61	12	98	8.000000	0	0	104
62	1	94	8.000000	35	0	74
63	84	86	8.000000	0	0	84
64	74	79	8.000000	0	0	88
65	18	73	8.000000	0	52	85
66	52	55	8.000000	0	0	80
67	31	48	8.000000	0	0	98
68	16	40	8.000000	0	0	77
69	19	42	8.333333	0	46	88
70	4	53	8.400000	51	53	75
71	3	101	8.571428	56	0	94
72	37	66	8.785714	47	36	82
73	14	17	8.838235	30	59	81
74	1	69	9.000000	62	0	94
75	4	100	9.181818	70	0	87
76	6	51	9.200000	0	57	91
77	2	16	9.200000	54	68	89
78	11	113	9.333333	41	0	105
79	21	57	9.428572	50	38	95
80	8	52	9.444445	58	66	93
81	14	41	9.684211	73	55	90
82	37	97	9.944445	72	0	91
83	5	111	10.000000	0	0	86
84	32	84	10.000000	0	63	102
85	18	76	10.000000	65	0	95

******HIERARCHICAL CLUSTER ANALYSIS******

Agglomeration Schedule CONTINUED

	Clusters Combined:			Stage Cluster 1st Appears:		Next
Stage	Cluster 1	Cluster 2	Coefficient	Cluster 1	Cluster 2	Stage
86	5	36	10.000000	83	0	96
87	4	29	10.000000	75	0	92
88	19	74	10.133333	69	64	102
89	2	64	10.190476	77	60	98
90	14	72	10.438095	81	0	97
91	6	37	10.857142	76	82	100
92	4	54	10.879121	87	0	99
93	8	89	10.933333	80	0	108
94	1	3	11.127273	74	71	106
95	18	21	11.303030	85	79	104
96	5	90	11.333333	86	0	111
97	14	35	11.350649	90	0	103
98	2	31	11.555555	89	67	107
99	4	22	11.676190	92	0	105
100	6	63	11.828571	91	0	109
101	65	107	12.000000	0	0	107
102	19	32	12.166667	88	84	110
103	14	104	12.458498	97	0	106
104	12	18	12.483517	61	95	110
105	4	11	12.771242	99	78	109
106	1	14	13.472371	94	103	108
107	2	65	13.963636	98	101	114
108	1	8	14.105708	106	93	112
109	4	6	14.227273	105	100	111
110	12	19	14.418972	104	102	112
111	4	5	15.207208	109	96	113
112	1	12	15.799186	108	110	113
113	1	4	16.757841	112	111	114
114	1	2	17.484058	113	107	0

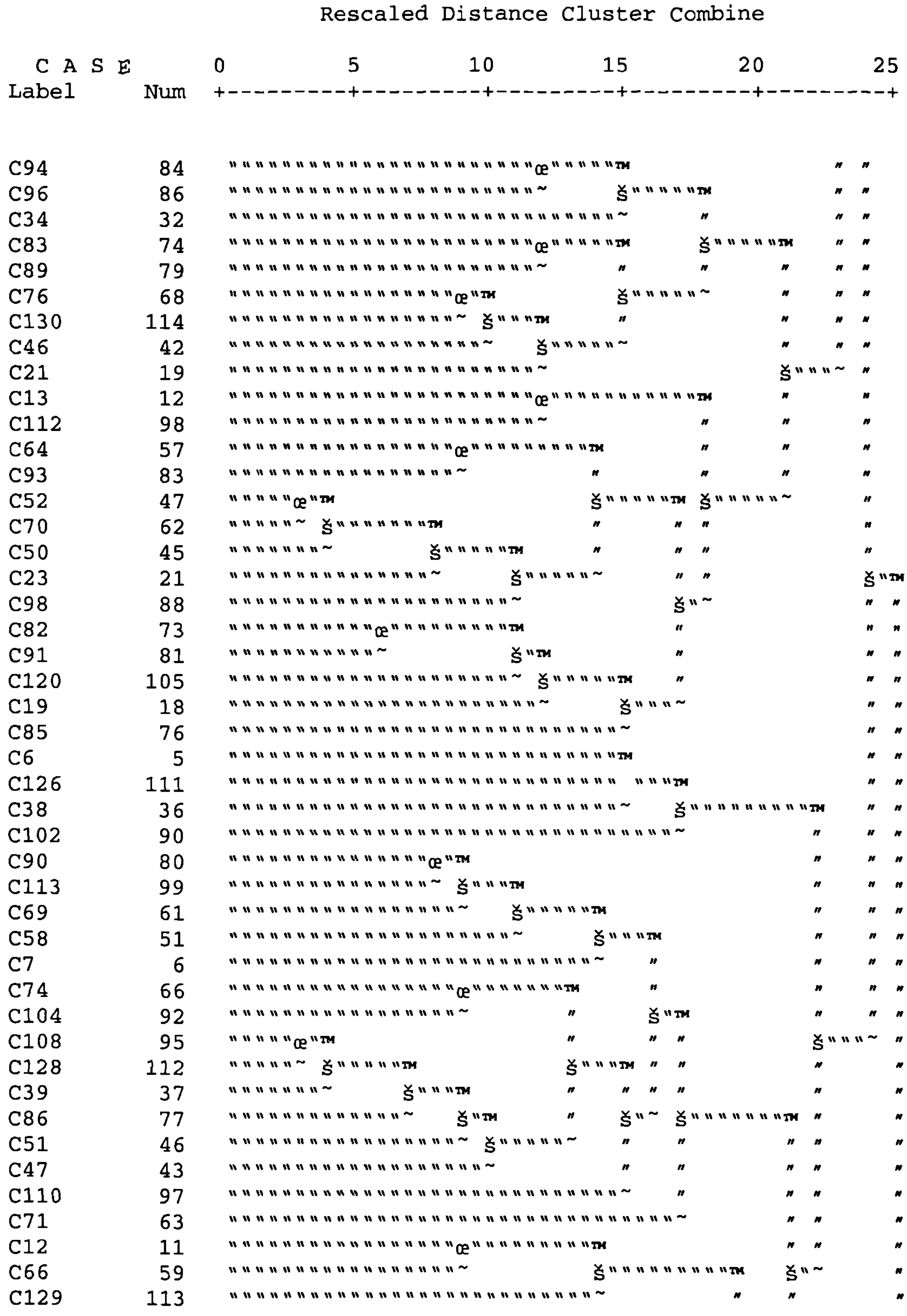
HIERARCHICAL CLUSTER ANALYSIS

Dendrogram using Average Linkage (Within Group)

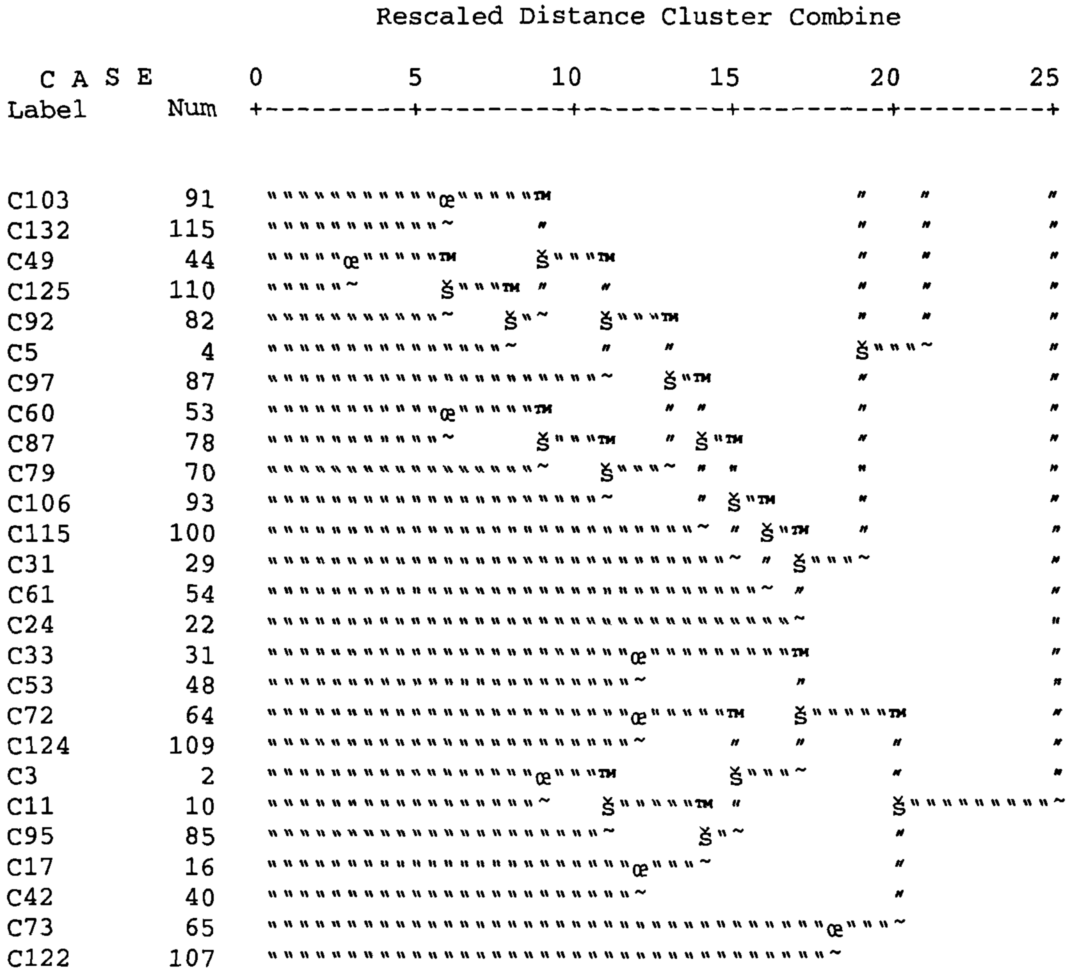
```
                         Rescaled Distance Cluster Combine
C A S E           0         5        10        15        20        25
Label      Num    +---------+---------+---------+---------+---------+
```

Label	Num
C40	38
C84	75
C30	28
C32	30
C118	103
C65	58
C18	17
C117	102
C57	50
C63	56
C67	60
C109	96
C29	27
C35	33
C15	14
C123	108
C26	24
C44	41
C55	49
C75	67
C81	72
C37	35
C119	104
C25	23
C27	25
C8	7
C28	26
C4	3
C41	39
C116	101
C2	1
C121	106
C107	94
C78	69
C16	15
C80	71
C9	8
C14	13
C10	9
C36	34
C22	20
C59	52
C62	55
C99	89

Dendrogram CONTINUED



Dendrogram CONTINUED



End of Appendix H
(Source: SPSS output)

APPENDIX J :
RATING BY G1 OF ATTRIBUTES WHICH INFLUENCE THEIR NEEDS

APPENDIX J : RATINGS BY MEMBERS OF G1 OF ATTRIBUTES WHICH INFLUENCE THEIR NEEDS

Introduction

Through the second questionnaire, members of G1 expressed the extent to which 23 attributes that were presented to them influence(d) their needs and/or values. The rating of these attributes by clients belonging to group G1 is given in the following Table, where:

F_i refers to the *i*th attribute; and,

Client, the code name assigned to the client who rated the attributes.

Dots within the cells of the Table indicate attributes that were not rated by the client in concern. For instance, the client referenced as C44 did not rate F1 and F2 but explicitly said that F3, F4 and F5 did not have an influence on their organisation.

COLLATION OF THE RATINGS BY MEMBERS OF G1 OF ATTRIBUTES THAT INFLUENCE(D) THEIR NEEDS

	ATTRIBUTE:																	
Client	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18
C107	50.00	90.00	90.00	10.00	10.00	90.00	50.00	70.00	70.00	.00	30.00	50.00	70.00	70.00	50.00	70.00	90.00	90.00
C25	10.00	30.00	10.00	10.00	.00	70.00	50.00	50.00	30.00	70.00	30.00	10.00	30.00	90.00	30.00	10.00	30.00	10.00
C62	10.00	10.00	10.00	10.00	10.00	90.00	90.00	90.00	90.00	90.00	10.00	70.00	90.00	70.00	90.00	90.00	90.00	70.00
C44	.	.	.00	.00	.00	90.00	30.00	30.00	70.00	70.00	30.00	10.00	70.00	70.00	70.00	70.00	50.00	50.00
C99	10.00	10.00	.00	.00	.00	70.00	10.00	50.00	10.00	50.00	.00	10.00	10.00	30.00	10.00	.00	30.00	10.00
C65	50.00	90.00	70.00	10.00	10.00	90.00	90.00	30.00	90.00	70.00	10.00	10.00	.	90.00	50.00	10.00	50.00	50.00
C75	50.00	90.00	10.00	.00	.00	90.00	50.00	30.00	70.00	70.00	70.00	70.00	70.00	90.00	30.00	.	10.00	10.00
C10	70.00	90.00	50.00	70.00	50.00	90.00	90.00	90.00	90.00	90.00	70.00	90.00	50.00	90.00	90.00	90.00	90.00	70.00
C119	10.00	90.00	.00	.00	.00	90.00	90.00	.00	70.00	70.00	10.00	10.00	10.00	50.00	.00	70.00	70.00	70.00
C41	.00	30.00	10.00	10.00	10.00	90.00	70.00	90.00	90.00	90.00	90.00	30.00	70.00	90.00	90.00	90.00	70.00	70.00
C27	70.00	10.00	10.00	10.00	10.00	30.00	50.00	10.00	90.00	90.00	70.00	90.00	70.00	90.00	70.00	30.00	70.00	90.00
C8	10.00	10.00	10.00	10.00	90.00	90.00	90.00	70.00	70.00	30.00	70.00	50.00	50.00	30.00	30.00	70.00	70.00	30.00
C40	90.00	90.00	70.00	.00	.00	90.00	50.00	70.00	90.00	90.00	70.00	70.00	90.00	90.00	90.00	70.00	90.00	90.00
C35	10.00	70.00	90.00	70.00	10.00	90.00	90.00	70.00	30.00	30.00	10.00	.00	70.00	70.00	50.00	50.00	90.00	90.00
C67	.00	.00	.00	.00	.00	70.00	30.00	70.00	70.00	50.00	.00	.00	70.00	90.00	30.00	90.00	90.00	90.00
C9	10.00	30.00	70.00	50.00	10.00	30.00	30.00	30.00	70.00	50.00	50.00	50.00	10.00	30.00	30.00	50.00	90.00	90.00
C18	10.00	10.00	30.00	30.00	10.00	50.00	50.00	50.00	70.00	70.00	10.00	10.00	70.00	70.00	50.00	50.00	30.00	30.00
C123	70.00	70.00	.00	.00	.00	70.00	.00	.00	90.00	90.00	70.00	90.00	30.00	90.00	50.00	70.00	70.00	70.00
C118	10.00	90.00	.00	.00	.00	90.00	.00	.00	10.00	10.00	.00	10.00	30.00	10.00	50.00	90.00	30.00	10.00
C109	.00	.00	.00	.00	.00	90.00	90.00	90.00	70.00	70.00	30.00	70.00	50.00	50.00	30.00	30.00	70.00	70.00
C81	.00	90.00	.00	.00	.00	90.00	70.00	70.00	90.00	.00	30.00	50.00	70.00	50.00	.00	70.00	90.00	90.00
C14	10.00	10.00	70.00	.00	.00	90.00	50.00	70.00	90.00	90.00	70.00	70.00	90.00	90.00	90.00	70.00	90.00	90.00
C78	10.00	30.00	10.00	10.00	.00	90.00	90.00	.00	70.00	70.00	10.00	10.00	10.00	50.00	10.00	70.00	70.00	70.00
C57	.00	10.00	10.00	10.00	10.00	90.00	70.00	90.00	90.00	90.00	70.00	30.00	70.00	90.00	90.00	90.00	70.00	70.00
C30	.00	30.00	10.00	10.00	10.00	90.00	70.00	90.00	90.00	90.00	70.00	30.00	70.00	90.00	90.00	90.00	70.00	70.00
C16	.00	90.00	.00	.00	.00	90.00	70.00	70.00	90.00	.00	30.00	50.00	70.00	50.00	.00	70.00	90.00	90.00
C55	30.00	10.00	10.00	10.00	10.00	30.00	50.00	10.00	70.00	90.00	70.00	90.00	70.00	90.00	70.00	30.00	50.00	90.00
C29	10.00	70.00	90.00	30.00	10.00	90.00	90.00	50.00	30.00	30.00	10.00	.00	70.00	70.00	50.00	50.00	90.00	90.00
C26	10.00	90.00	.00	.00	.00	70.00	90.00	10.00	90.00	70.00	10.00	10.00	10.00	50.00	10.00	70.00	90.00	70.00

Collation of the clients' ratings continued in the next page

Collation of the ratings by members of G1 continued

	ATTRIBUTE:				
Client	F19	F20	F21	F22	F23
C107	50.00	50.00	50.00	50.00	30.00
C25	.00	10.00	10.00	70.00	70.00
C62	10.00	10.00	10.00	10.00	10.00
C44	30.00	10.00	10.00	10.00	10.00
C99	10.00	10.00	10.00	10.00	.00
C65	10.00	.00	.00	.00	.00
C75	.00	.00	.00	50.00	50.00
C10	90.00	70.00	70.00	70.00	70.00
C119	10.00	.00	.00	.00	.00
C41	.00	.00	10.00	10.00	.00
C27	.00	10.00	50.00	30.00	10.00
C8	30.00	30.00	30.00	30.00	.
C40	30.00	50.00	10.00	70.00	10.00
C35	.00	30.00	10.00	10.00	10.00
C67	50.00	10.00	10.00	10.00	10.00
C9	30.00	90.00	10.00	30.00	30.00
C18	10.00	10.00	10.00	30.00	30.00
C123	70.00	70.00	50.00	50.00	10.00
C118	.	.00	.00	.00	.00
C109	30.00	30.00	30.00	30.00	30.00
C81	.00	.00	70.00	.00	.00
C14	30.00	50.00	10.00	70.00	10.00
C78	10.00	10.00	10.00	10.00	10.00
C57	10.00	10.00	10.00	10.00	10.00
C30	10.00	.00	10.00	10.00	.00
C16	.00	.00	70.00	.00	.00
C55	10.00	10.00	50.00	30.00	10.00
C29	.00	30.00	10.00	10.00	10.00
C26	10.00	.00	10.00	.00	.00

(End of collation).

APPENDIX K :
RATING BY G2 OF ATTRIBUTES WHICH INFLUENCE THEIR NEEDS

APPENDIX K : RATINGS BY MEMBERS OF G2 OF ATTRIBUTES WHICH INFLUENCE THEIR NEEDS

Introduction

Through the second questionnaire, members of G1 expressed the extent to which 23 attributes that were presented to them influence(d) their needs and/or values. The ratings of the clients belonging to group G2 are given in the following Table. The principles used in the collation od Appendix J are equally employed here, that is:

F_i refers to the *i*th attribute;

Client, the code name assigned to the client who rated the attributes; and,

Dots within the cells of the Table indicate attributes that were not rated by a client.

COLLATION OF THE RATINGS BY MEMBERS OF G2 OF ATTRIBUTES THAT INFLUENCE(D) THEIR NEEDS

	ATTRIBUTE																	
Client	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18
C69	90.00	90.00	10.00	10.00	10.00	90.00	30.00	70.00	90.00	50.00	30.00	50.00	90.00	90.00	50.00	.00	70.00	70.00
C49	10.00	70.00	10.00	10.00	10.00	70.00	70.00	70.00	70.00	50.00	30.00	30.00	70.00	70.00	50.00	30.00	90.00	90.00
C6	10.00	10.00	10.00	10.00	10.00	30.00	10.00	90.00	30.00	90.00	10.00	30.00	90.00	90.00	50.00	70.00	10.00	10.00
C106	70.00	70.00	50.00	50.00	70.00	50.00	50.00	30.00	50.00	30.00	70.00	70.00	50.00	70.00	10.00	50.00	70.00	10.00
C31	10.00	10.00	50.00	.00	.00	30.00	30.00	50.00	70.00	50.00	.00	.00	50.00	70.00	30.00	10.00	50.00	50.00
C51	90.00	90.00	10.00	10.00	10.00	10.00	10.00	10.00	90.00	90.00	10.00	70.00	70.00	90.00	70.00	70.00	90.00	30.00
C12	70.00	70.00	.00	50.00	.00	10.00	30.00	50.00	10.00	10.00	70.00	70.00	70.00	70.00	30.00	50.00	30.00	30.00
C86	70.00	70.00	10.00	10.00	10.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	50.00	70.00	70.00	70.00
C47	30.00	70.00	10.00	.00	.00	70.00	50.00	30.00	70.00	70.00	70.00	90.00	90.00	90.00	70.00	50.00	70.00	70.00
C58	90.00	90.00	70.00	10.00	10.00	90.00	70.00	90.00	90.00	70.00	50.00	70.00	70.00	70.00	90.00	90.00	70.00	70.00
C92	10.00	30.00	50.00	50.00	30.00	30.00	50.00	50.00	10.00	70.00	10.00	10.00	10.00	30.00	10.00	10.00	70.00	70.00
C87	.00	90.00	70.00	10.00	10.00	90.00	70.00	70.00	90.00	30.00	10.00	10.00	90.00	70.00	.	.	70.00	70.00
C5	10.00	50.00	10.00	30.00	10.00	30.00	50.00	50.00	70.00	90.00	10.00	30.00	50.00	70.00	10.00	10.00	70.00	70.00
C113	10.00	.00	.00	.00	.00	.00	.00	.00	90.00	70.00	50.00	50.00	50.00	50.00	10.00	10.00	70.00	70.00
C129	30.00	70.00	10.00	10.00	10.00	30.00	30.00	50.00	70.00	.	.	50.00	10.00	30.00	10.00	50.00	50.00	50.00
C66	10.00	70.00	10.00	10.00	10.00	70.00	70.00	70.00	70.00	50.00	30.00	30.00	70.00	70.00	50.00	30.00	90.00	90.00
C108	90.00	90.00	10.00	10.00	10.00	90.00	30.00	70.00	90.00	50.00	30.00	50.00	90.00	90.00	50.00	.00	70.00	70.00
C115	70.00	70.00	50.00	50.00	70.00	50.00	50.00	30.00	50.00	30.00	70.00	70.00	50.00	70.00	10.00	50.00	70.00	10.00
C39	10.00	10.00	50.00	.00	.00	30.00	30.00	50.00	70.00	50.00	.00	.00	50.00	70.00	30.00	10.00	50.00	50.00
C60	10.00	10.00	10.00	10.00	10.00	30.00	10.00	90.00	30.00	90.00	10.00	30.00	90.00	90.00	50.00	70.00	10.00	10.00
C126	90.00	90.00	10.00	10.00	10.00	10.00	10.00	10.00	90.00	90.00	10.00	70.00	70.00	90.00	70.00	70.00	90.00	30.00
C102	30.00	70.00	10.00	10.00	10.00	30.00	30.00	50.00	70.00	.	.	50.00	10.00	30.00	10.00	50.00	50.00	50.00
C132	10.00	.00	.00	.00	.00	.00	.00	.00	90.00	70.00	50.00	50.00	50.00	50.00	10.00	10.00	70.00	70.00
C24	10.00	50.00	10.00	30.00	10.00	30.00	50.00	50.00	70.00	90.00	10.00	30.00	50.00	70.00	10.00	10.00	70.00	70.00

Collation of the rating of attributes continued in the next page

Collation of ratings by members of G2 continued

	ATTRIBUTE:				
Client	F19	F20	F21	F22	F23
C69	70.00	.00	.00	10.00	.00
C49	50.00	.00	.00	.00	.00
C6	10.00	10.00	10.00	30.00	30.00
C106	50.00	30.00	30.00	30.00	30.00
C31	*30.00*	*.00*	*.00*	*10.00*	*.00*
C51	.00	10.00	10.00	10.00	10.00
C12	.00	30.00	10.00	30.00	30.00
C86	70.00	10.00	10.00	10.00	10.00
C47	*10.00*	*10.00*	*30.00*	*50.00*	*.00*
C58	70.00	10.00	10.00	50.00	10.00
C92	.00	.00	10.00	30.00	.00
C87	10.00	10.00	10.00	10.00	10.00
C5	.00	.00	10.00	10.00	10.00
C113	90.00	30.00	10.00	10.00	.00
C129	*70.00*	*30.00*	*50.00*	30.00	10.00
C66	50.00	.00	.00	.00	.00
C108	*70.00*	.00	.00	10.00	.00
C115	50.00	30.00	30.00	30.00	30.00
C39	30.00	.00	.00	10.00	.00
C60	10.00	10.00	10.00	30.00	30.00
C126	.00	10.00	10.00	10.00	10.00
C102	70.00	30.00	50.00	30.00	10.00
C132	90.00	30.00	10.00	10.00	.00
C24	.00	.00	10.00	10.00	10.00

(End of collation)

APPENDIX L :

DEFINITION OF NEEDS BY G1 AND G2

APPENDIX L : DEFINITION OF NEEDS BY G1 AND G2

This Appendix contains a comparative evaluation of the meanings attached to generic needs by members of G1 and G2. Section 8.2.1 showed a leading analysis in respect of the meanings attached to aesthetics by G1 and G2. The proceeding analyses for the seven other needs of economy, function, quality, relations, safety, lack of surprises (commitment) and time are reported here.

L1 Difference(s) between G1 and G2 in the meanings of economy

The frequencies with which the different attributes of economy were scored by G1 and G2 are shown in Table L.1. As in Section 8.2.1, these frequencies were tested for significant differences where the null and alternative hypotheses were:

H_0: The frequencies by which the attributes of economy are desired are independent of the client.

H_1 : The frequencies by which the attributes of economy are desired are dependent on the client.

The data used in the analysis are shown in Tables L.1 & L.2.

Table L.1 : Frequencies by which the meanings of economy were desired by G1 and G2

	Attribute:	Frequency G1	Frequency G2
E1	Lowest price whatsoever	2	4
E2	Price of the product to meet a given budget	30	23
E3	Reducing tendering costs by inviting few bidders	5	3
E4	Balance between capital and maintenance costs	25	22
E5	Minimising taxation benefits	3	0
E6	Indication of a firm price with minimal variations	21	18
E7	*Energy efficiency*	*1*	*1*

NB: Attributes in italics were specified by clients while completing their questionnaires.

Table L.2 : Actual and expected frequencies by which some meanings of economy were desired by G1 and G2

	Frequencies		
Attribute	**G1**	**G2**	**Total**
E1	2 *(3.31)*	4 *(2.69)*	**6**
E2	30 *(29.22)*	23 *(23.78)*	**53**
E3	5 *(4.41)*	3 *(3.59)*	**8**
E4	25 *(25.91)*	22 *(21.09)*	**47**
E5	3 *(1.65)*	0 *(1.35)*	**3**
E6	21 *(21.50)*	18 *(17.50)*	**39**
Total	**86**	**70**	**156**

The degrees of freedom (d.f.) are = (6-1)(2-1) = 5;

$\chi^2_{threshold}$ = 11.070; and,

$\chi^2_{empirical}$ = 3.93.

The empirical chi-square value is lower than the threshold value, therefore the proportions by which the attributes of economy have been scored by G1 and G2 are not significantly different from each other. The additional feature of energy efficiency was expressed once by both G1 and G2 (see Table L.1), also showing a similarity between the two clients.

L2 Difference(s) in the meaning of function

The frequencies by which the different attributes of function were scored by G1 and G2 are shown in Table L.3.

The null and alternative hypotheses being tested were:

H_0: The frequencies by which the attributes of 'function' are desired are independent of the client.

H_1 : The frequencies by which the attributes of 'function' are desired are dependent on the client.

Table L.3 : Frequencies by which the meanings of function were desired by G1/G2

	Attribute:	Frequency G1	G2
F1	Building to be operationally efficient with its intended purpose	35	34
F2	Durable buildings	28	17
F3	Keeping existing buildings operational during construction	12	6
F4	*Buildings to be meet for different users*	*0*	2
F5	*Buildings to be adaptable to users with special needs (e.g. disabled)*	*0*	2

The outlay of the data for the analysis is in Table L.4. The degrees of freedom (d.f.) are = (3-1)(2-1) = 2;

$\chi^2_{threshold}$ = 5.991; and,

$\chi^2_{empirical}$ = 2.29.

Table L.4 : Actual and expected frequencies by which some meanings of function were desired by G1 and G2

Attribute	Frequencies G1	G2	Total
F1	35 *(39.20)*	34 *(29.80)*	**69**
F2	28 *(25.57)*	17 *(19.43)*	**45**
F3	12 *(10.22)*	6 *(7.77)*	**18**
Total	**75**	**57**	**132**

The empirical chi-square value is lower than the threshold value. Going by this outcome the proportions by which the attributes of function have been scored by G1 and G2 are not significantly different. Two further attributes were twice voted by G2. They pertain to the functioning of the building being suitable for other users, especially those with special needs. They were both mentioned twice.

L3 Difference(s) in the meaning of quality

The frequencies by which the different attributes of quality were scored by G1 and G2 are shown in Table L.5 while the actual data derived from it and used for the analysis is shown in Table L.6.

Table L.5 : Frequencies by which the meanings of quality were desired by G1 and G2

	Attribute:	Frequency G1	Frequency G2
Q1	Quality of the product to match current standards	30	19
Q2	Innovative design incorporating high/latest technology	11	6
Q3	Building to reflect your activities and image	15	9
Q4	Value for money (i.e., desired quality at appropriate price)	34	33
Q5	*Building materials and workmanship to comply with statutory standards (e.g., B.S)*	*1*	*1*
Q6	*Flexible buildings that can easily be translated to other uses*	*0*	*2*

Table L.6 : Actual and expected frequencies by which some meanings of quality were desired by G1 and G2

Attribute	Frequencies G1	Frequencies G2	Total
Q1	30 *(28.09)*	19 *(20.91)*	**49**
Q2	11 *(9.75)*	6 *(7.25)*	**17**
Q3	15 *(13.76)*	9 *(10.24)*	**24**
Q4	34 *(38.41)*	33 *(28.59)*	**67**
Total	**90**	**67**	**157**

The degrees of freedom (d.f.) are = (4-1)(2-1) = 3;

$\chi^2_{threshold}$ = 7.815; and,

$\chi^2_{empirical}$ = 2.129.

The empirical chi-square value is lower than the threshold value, therefore the proportions by which the attributes of quality have been scored by G1 and G2 are not significantly different from each other.

In addition, both clients mentioned (once) the need for the quality of materials and workmanship to comply to relevant British Standards. After this, G2 on two occasions mentioned the need for products that can easily be translated into uses other than those originally intended. This attribute pertains more to the need of function than quality. Being mentioned a few times, it was difficult to test if the desire of these additional attributes were statistically different between the two clients.

L4 Difference(s) between G1 and G2 in the meanings of relations

The frequencies by which the different attributes of relations were scored by G1 and G2 are shown in Table L.7 while the data derived from it and used for the analysis are presented in Table L.8.

Table L.7 : Frequencies by which the meanings of relations were desired by G1 and G2

		Frequency	
	Attribute:	**G1**	**G2**
R1	Avoidance of disputes	24	21
R2	Familiarity with contractor	9	12
R3	Desire to be actively involved in your project(s)	28	20
R4	Desire to be kept informed about the project throughout its life	25	24
R5	Non-confrontational relationship with the contractor	20	16
R6	Probity (Internal and Public accountability)	25	19
R7	*A call for partnering relationships between project participants*	*3*	*1*
R8	*Quick remedying of defects by contractors*	*0*	*1*
R9	*Participants to be handy or easily accessible*	*0*	*1*
R10	*Ability of project team members to adjust to dynamic situations*	*1*	*0*
R11	*Communications*	*1*	*0*

Table L.8 : Actual and expected frequencies by which some meanings of relations were desired by G1 and G2

	Frequencies		
Attribute	G1	G2	Total
R1	24 *(24.26)*	21 *(20.74)*	**45**
R2	9 *(11.32)*	12 *(9.67)*	**21**
R3	28 *(25.88)*	20 *(22.12)*	**48**
R4	25 *(26.42)*	24 *(22.58)*	**49**
R5	20 *(19.41)*	16 *(16.59)*	**36**
R6	25 *(23.72)*	19 *(20.28)*	**44**
Total	**131**	**112**	**243**

The degrees of freedom (d.f.) are = (6-1)(2-1) = 5;

$\chi^2_{threshold} = 11.070$;

$\chi^2_{empirical} = 1.774$.

The empirical chi-square value is lower than the threshold value. This outcome suggests that the proportions by which the attributes of quality have been scored by G1 and G2 are not significantly different from each other.

Although five additional attributes were mentioned by the clients, most of them seem to concern ad-hoc problems. The need for partnering relationships which received the highest votes in this later set of attributes is an issue that should be decided upon while the project procurement option is being selected. The mentioning of this issue by clients reinforces the discussion in chapter 2 where it was advocated that clients' needs be identified at the commencement of project schemes.

If a project team adopts a traditional approach and proceeds along that perspective and later learns that the client had preferred a partnering arrangement, then the project would have been run on the wrong course. One way of avoiding such a mistake is through appropriate and elaborate communication at the right time. Chapter one indicated that the research was being approached from the perspective of communications. Incidentally too, G1 reiterated the role of communications in the course of project delivery.

L5 Difference(s) in the meaning of safety

The frequencies by which the different attributes of safety were voted by G1 and G2 are shown in Table L.9. The additional attribute of safety mentioned by both clients is the need for compliance with CDM regulations. The frequencies by which this additional attribute were scored by the duo are such that the combined three attributes of safety can be analysed together without violating the axioms of the analytical technique being used. Thus the cumulative data to be analysed in respect of safety is shown in Table L.9.

Table L.9 : Frequencies by which the meanings of safety were desired by G1 and G2

	Attribute:	Frequency G1	G2
S1	Minimal exposure to risk for the client (and others)	26	21
S2	Recognition of risks associated with the project	34	28
S3	*Compliance with CDM regulations*	*7*	2

Table L.10 : Actual and expected frequencies by which the meanings of safety were desired by G1 and G2

Attribute	Frequencies G1	G2	Total
S1	26 *(26.69)*	21 *(20.31)*	**47**
S2	34 *(35.20)*	28 *(26.80)*	**62**
S3	7 *(5.11)*	2 *(3.89)*	**9**
Total	**67**	**51**	**118**

The degree of freedom (d.f.) is = (3-1)(2-1) = 2;

$\chi^2_{threshold} = 5.991$; and,

$\chi^2_{empirical} = 1.753$.

The empirical chi-square value is lower than the threshold value, therefore the proportions by which the attributes of quality were scored by G1 and G2 are not significantly different from each other.

L6 Difference(s) in the meaning of 'no-surprises' (commitment)

The frequencies with which the different attributes of 'no-surprises' were scored by G1 and G2 are shown in Table L.11. The data analysed which was derived from Table L.11 is shown in Table L.12.

Table L.11 : Frequencies by which the meanings of "no-surprises" were desired by G1 and G2

	Attribute:	Frequency G1	G2
NS1	Clear allocation of responsibilities between you and contractor	32	26
NS2	Flexibility to change the design during construction	14	7
NS3	Avoidance of claims	27	23
NS4	Guarantees of, and on construction	25	24
NS5	*Quick remedying of defective work*	*1*	*0*
NS6	*Complete design prior to construction*	*1*	*0*
NS7	*Contractor to be able to control subcontractors*	*1*	*0*
NS8	*(In)stability of user requirements*	*0*	*1*

Table L.12 : Actual and expected frequencies by which some meanings of function were desired by G1 and G2

Attribute	Frequencies G1	G2	Total
NS1	32 *(32.11)*	26 *(25.89)*	**58**
NS2	14 *(11.63)*	7 *(9.37)*	**21**
NS3	27 *(27.68)*	23 *(22.32)*	**50**
NS4	25 *(26.58)*	23 *(21.42)*	**48**
Total	**98**	**79**	**177**

The degrees of freedom (d.f.) are = (4-1)(2-1) = 3;

$\chi^2_{threshold} = 7.815$; and,

$\chi^2_{empirical} = 1.331$.

The empirical chi-square value is lower than the threshold value, therefore the proportions by which the attributes of quality were scored by G1 and G2 are not significantly different from each other. Although four more additional attributes were indicated by the clients, they were each mentioned only once by either G1 or G1.

However, one of the additional attributes (the varying nature of user requirements) is outstandingly notable. The turnover of building users is relatively higher than that of owners. While the requirements of an owner can be identified easily because (s)he is known and can be accessed at the beginning of a project, those of users are more dynamic in that users are multiple, different and often changing, even for a specific building. There is a need to balance the expectations of owners with users where the two are different. To avoid confusion, the present research was restricted to the requirements of building owners.

L7 Difference(s) in the meaning of time

The frequencies with which the different attributes of time were scored by G1 and G2 are shown in Table L.13 and the data derived from it for the analysis are displayed in Table L.14.

Table L.13 : Frequencies by which the meanings of time were desired by G1 and G2

		Frequency	
	Attribute:	**G1**	**G2**
T1	Timely construction (i.e., being on schedule)	37	36
T2	Securing timely planning approvals	24	14
T3	High speed of design and construction	9	11
T4	Early start	8	11
T5	Minimal interference	24	9
T6	*Forward planning*	*1*	*0*
T7	*Adequacy of brief*	*1*	*0*
T8	*Financial clearance to be secured on time by contractor (?)*	*1*	*0*

Table L.14 : Actual and expected frequencies by which some meanings of time were desired by G1 and G2

	Frequencies		
Attribute	**G1**	**G2**	**Total**
T1	37 *(40.51)*	36 *(32.49)*	**73**
T2	23 *(20.53)*	14 *(16.47)*	**37**
T3	9 *(11.10)*	11 *(8.90)*	**20**
T4	8 *(10.54)*	11 *(8.46)*	**19**
T5	24 *(18.31)*	9 *(14.69)*	**33**
Total	**101**	**81**	**182**

The degrees of freedom (d.f.) are = (5-1)(2-1) = 4;

$\chi^2_{threshold} = 9.488$;

$\chi^2_{empirical} = 7.591$.

The empirical chi-square value is lower than the threshold value, therefore the proportions by which the attributes of quality have been scored by G1 and G2 are not significantly different from each other. The additional three attributes mentioned by G1 (see Table L.13) are noted, amongst which is the call for adequate briefs. The literature review in Chapter 2 had indicated from a scholar's perspective that construction briefing is currently inadequate. A research to appraise the briefing process and to develop a uniform approach for construction briefing might be needed to improve the status quo.

The analysis in respect of time completes the comparative evaluations. The analyses of this Appendix are summarised in section 8.2.2.

APPENDIX M :

DIFFERENCES BETWEEN G1 AND G2 IN THE RATING OF ATTRIBUTES THAT INFLUENCE NEEDS

APPENDIX M : DIFFERENCES BETWEEN G1 AND G2 IN THE RATING OF ATTRIBUTES THAT INFLUENCE NEEDS

Testing for significant differences in the scoring of predominant attributes by G1 and G2

The following analyses are a follow-on from the computation in Section 8.5 where statistical differences between the scoring of predominant attributes by G1 and G2 were investigated. The analyses follow the pattern of section 8.5.3.

M1 Testing for statistical difference in the scoring of F6 (Type of facility built)

The data analysed is as follows:

Table M.1 : Data in respect of F6

	Information	
Statistic	G1	G2
Mean ($\bar{x}_i$)	78.97	43.33
Standard deviation (s_i)	19.70	29.73
Sample size (n_i)	29	24

Hypotheses:

H_0: $x_1 = x_2$

H_a: $x_1 \neq x_2$

The degrees of freedom (df) obtained from the earlier specified formula (see Section 8.5.3) was: df = 38.568 ≅ 39;

The corresponding critical values $\pm t_{0.025}$ @ 39df ≅ ±2.021; and,

Empirically, t = 5.0297 ≅ 5.030.

The computed t value falls outside the range of the critical values ± 2.069. Since the empirical value of t exceeded the critical value, it was concluded that there was a statistical difference between the two mean scores.

M2 Testing for statistical difference in the scoring of F7 (i.e., Type of development: new or refurbishment)

The data analysed is shown in the next Table.

Table M.2 : Data in respect of F7

	Information	
Statistic	**G1**	**G2**
Mean ($\bar{x}_i$)	60.34	37.50
Standard deviation (s_i)	28.47	23.27
Sample size (n_i)	29	24

Hypotheses:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$.

The degrees of freedom (df) = 50.996 ≅ 51;

The critical values of $\pm t_{0.05/2} = \pm t_{0.025}$ @ 51df ≅ ± 2.000; and,

The empirical value was found to be: $t =$ 3.2137 ≅ 3.214.

The computed t value fell outside the range of the critical values (± 2.000) meaning that there was a statistical difference between the two mean scores.

M3 Testing for statistical difference in the scoring of F9 (i.e., Type of clients/customers)

The data analysed is shown in the next Table.

Table M.3 : Data in respect of F9

	Information	
Statistic	G1	G2
Mean ($\bar{x}_i$)	70.69	66.67
Standard deviation (s_i)	24.77	24.79
Sample size (n_i)	29	24

Hypotheses:

H_0: $x_1 = x_2$

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 49.148 ≅ 49;

The critical values of $\pm t_{0.05/2} = \pm t_{0.025}$ @ 49df ≅ ±2.021; and,

The empirical value of $t =$ 0.58786 ≅ 0.588.

The computed t value fell within the range of the critical values of: ±2.021. Since the empirical value of t did not exceed the critical value, it was concluded that there was no statistical difference between the two mean scores.

M4 Testing for a difference in the scoring of F10 (i.e., Expressed desires of clients/customers)

The data analysed is shown in the next Table.

Table M.4 : Data in respect of F10

Statistic	Information G1	G2
Mean ($\bar{x}_i$)	61.83	61.82
Standard deviation (s_i)	30.56	23.63
Sample size (n_i)	29	22

Hypotheses:

H_0: $x_1 = x_2$

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 48.970 $\cong$ 49;

The critical values of $t_{0.05/2} = \pm t_{0.025}$ @ 49df $\cong \pm 2.000$; and,

The empirical value of $t = 0.0013 \cong 0.001$.

This computed t value, like its predecessor, fell within the range of the critical values of: ± 2.000, meaning that there was no statistical difference between the two means.

M5 Testing for a difference in the scoring of F13 (i.e., Needs of other users of the facility)

The data analysed is shown in the next Table.

Table M.5 : Data in respect of F13

Statistic	Information G1	G2
Mean ($\bar{x}_i$)	55.00	60.83
Standard deviation (s_i)	26.46	25.01
Sample size (n_i)	28	24

Hypotheses:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 49.495 ≅ 49;

The critical values of $t_{0.05/2} = \pm t_{0.025}$ @ 49df ≅ ±2.000; and,

The empirical value of t = 0.8158 ≅ 0.816.

This computed t value fell within the range of the critical values of ±2.000, meaning that there was no statistical difference between the two means.

M6 Testing for a difference in the scoring of F14 (i.e., Special users' needs - e.g. disabled, etc.)

The data analysed is shown in the next Table.

Table M.6 : Data in respect of F14

	Information	
Statistic	**G1**	**G2**
Mean ($\bar{x}_i$)	68.62	69.17
Standard deviation (s_i)	23.86	19.09
Sample size (n_i)	29	24

Hypotheses:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 50.9546 ≅ 51;

The critical values of $t_{0.05/2} = \pm t_{0.025}$ @ 51df ≅ ±2.000; and,

The empirical value of t = -0.9322 ≅ -0.932.

This computed t value fell within the range of the critical values of ±2.000, meaning that there was no statistical difference between the two means.

M7 Testing for statistical difference in the scoring of F16 (i.e., Advise of in-house professionals)

The data analysed is shown in the next Table.

Table M.7 : Data in respect of F16

Statistic	Information G1	G2
Mean ($\bar{x}_i$)	61.07	37.83
Standard deviation (s_i)	26.57	27.95
Sample size (n_i)	28	23

Hypotheses:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 46.090 ≅ 46;

The critical values of $\pm t_{0.05/2} = \pm t_{0.025}$ @ 46df ≅ ±2.000; and,

The empirical value of $t =$ 3.021.

The empirical value of t fell outside the range of the critical values of $t = \pm 2.000$, meaning that there was a statistical difference between the two mean scores.

M8 Testing for statistical difference in the scoring of F17 (i.e., Planning regulations)

The data analysed is shown in the next Table.

Table M.8 : Data in respect of F17

Statistic	**Information G1**	**G2**
Mean ($\bar{x}_i$)	68.62	63.33
Standard deviation (s_i)	23.86	21.80
Sample size (n_i)	29	24

Hypotheses:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 40.4660 ≅ 40;

The values of $\pm t_{0.05/2} = \pm t_{0.025}$ @ 40df ≅ ±2.021; and,

The empirical value of t = 0.8424 ≅ 0.842.

The computed t value fell within the range of the critical values of ±2.021, meaning that there was no statistical difference between the two mean scores.

M9 Testing for statistical difference in the scoring of F18 (i.e., Building regulations)

The data analysed is shown in the next Table.

Table M.9 : Data in respect of F18

	Information	
Statistic	**G1**	**G2**
Mean ($\bar{x}_i$)	65.17	53.33
Standard deviation (s_i)	28.11	25.48
Sample size (n_i)	29	24

Hypotheses:

H_0: $x_1 = x_2$; and,

H_a: $x_1 \neq x_2$

The degrees of freedom (df) = 50.5549 ≅ 51;

The values of $\pm t_{0.05/2} = \pm t_{0.025}$ @ 51df ≅ ±2.000; and,

The empirical value of t = 1.60678 ≅ 1.607.

The computed t value fell within the range of the critical values of ±2.021, meaning that there was no statistical difference between the two mean scores. A summary of the foregoing analyses and the inference drawn thereof is given in Section 8.5.3.

End of Thesis